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The *armans* (pterygia), which occur on the sclerotic region and are five in number, consist of:

1. *Prastāryārma* (pterygium crassum of Fuchs)—an extensive, thin, slightly bluish red fleshy membrane on the sclera (scleral conjunctivitis).

2. *Śuklārma* (white pterygium)—a soft, slowly growing, white, plain membrane.

3. *Raktārma* (pterygium vasculosum of Fuchs)—fibrovascular membrane on the sclerotic coat, the color of a red lotus.

4. *Adhīmānsārma* (pterygium carnosum of Fuchs)—an extensive, soft, thick, succulent, liver-colored fleshy membrane.

5. *Snāyārma* (pterygium tenue membranaceum of Fuchs)—a rough, grayish, fibrofleshy patch, growing slowly in size.

The other diseases in this group are:

6. *Śuktika* (pinguecula)—raised, dark brown specks on the white coat of the eye, resembling flesh in color or having the color of an oyster-shell.

7. *Arjuna* (a blood-red raised speck on the sclera)—a single dot or speck on the sclerotic coat, colored red like a drop of hare's blood.

8. *Pīṣṭaka* (a grayish-looking fleshy spot on the sclera)—a raised, circular fleshy patch on the white coat of the eye, colored dull white, like a ricepaste.

9. *Śirā-jāla* (vascularization on the sclera; scleritis)—extensive red patches of hardened vessels spreading over the white coat of the eye and having the appearance of a network.

10. *Śirāja-pidakā* (phlyctenule covered with vascularization)—a crop of white papular growths on the sclerotic coat near the limbus, covered with shreds of vascularization.

11. *Balāsa* (a speck the color of bell metal covered by vessels)—a shining grayish white speck on the white coat of the eye covered with vascularization.

Four diseases of the black circle<sup>36</sup> of the eye were described as follows:

1. *Savṛana-śukra* (ulcerative keratitis)—a puncture-like depression, an abraded spot or area on the region of the cornea, giving a sensation as if the parts have been pricked with a needle and attended with excruciating pain and hot exudation.

2. *Avṛana-śukra* (nonulcerative keratitis; plastic keratitis)—a whitish abrasion on the cornea, like a speck of translucent cloud in the sky, attended with lachrymation and slight pain and due to *abhiśyanda* (ophthalmia).

*Avṛana-śukra* (plastic keratitis) of long standing and accompanied by thickening of the cornea may be cured only with the greatest difficulty. If the disease is of long duration and the cornea is mobile, and is covered with shreds of highly vascularized conjunctival tissue, which stretch down to the second layer and obstruct vision and are severed in the middle and marked with a reddish tint in the extremities (interstitial keratitis), cure is also difficult.

3. *Akṣīpākatyaya* (hypopyon)—ulceration of the entire region of the cornea, attended with acute pain.

4. *Ajakā-jata* (a sarcomatous growth invading the cornea)—a painful, fatty, reddish growth, like the dried feces of a goat, arising from beneath the cornea and attended with a reddish, slimy secretion.



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## THE PROBLEM OF THE ETIOLOGY OF TRACHOMA

I. RICKETTSIA

A. DE RÖTTH, M.D.  
CHICAGO

It is now generally accepted that *Bacterium granulosis* (Noguchi) does not cause trachoma.<sup>1</sup> Its pathogenic action consists in the production of folliculosis.<sup>2</sup>

The long-discussed epithelial cell inclusions of Prowazek and Halberstädter were discredited for a considerable length of time by the finding of different nonspecific inclusions of extracellular and intracellular origin on the trachomatous conjunctiva and of similar inclusions on conjunctivas affected with several other forms of conjunctivitis. Recent investigations of Lindner,<sup>3</sup> Aust,<sup>4</sup> Taborisky<sup>5</sup> and Rötth,<sup>6</sup> but especially those of Thygeson,<sup>7</sup> Thygeson and Proctor,<sup>8</sup> Thygeson, Proctor and Richards<sup>9</sup> and Thygeson and Richards,<sup>10</sup> have helped to disclose

---

From the State Eye Hospital, Budapest, Hungary, Prof. J. Imre, M.D., Director.

1. Robbins, H. R.: Role of *Bacterium Granulosis* in Trachoma, *Arch. Ophth.* **14**:629 (Oct.) 1935. Thygeson, P.: Analysis of Recent Studies on the Etiology of Trachoma, *Am. J. Ophth.* **19**:649, 1936.

2. Lindner, K.: Ist das *Bacterium Granulosis* Noguchi der Erreger des Trachoms? *Arch. f. Ophth.* **122**:391, 1929.

3. Lindner, K.: Ueber die Schwierigkeiten der Trachomforschung, *Ztschr. f. Augenh.* **57**:508, 1926.

4. Aust, O.: Beiträge zur Trachomforschung, *Arch. f. Ophth.* **123**:93, 1929.

5. Taborisky, J.: Experimentelle und klinische Untersuchungen über Trachom und trachomähnliche Erkrankungen der Bindehaut, *Arch. f. Ophth.* **123**:140, 1929; Die Provaczek-Halberstädterschen Körperchen und ihre klinische Bedeutung, *ibid.* **124**:455, 1930.

6. Rötth, A.: Ueber die Aetiologie des Trachoms, *Arch. f. Ophth.* **128**:381, 1932.

7. Thygeson, P.: The Nature of the Elementary and Initial Bodies of Trachoma, *Arch. Ophth.* **12**:307 (Sept.) 1934; Die Virusätiologie des Trachoms, abstracted, *Klin. Monatsbl. f. Augenh.* **100**:114, 1938.

8. Thygeson, P., and Proctor, F. T.: The Filtrability of Trachoma Virus, *Arch. Ophth.* **13**:1018 (June) 1935.

9. Thygeson, P.; Proctor, F. T., and Richards, P.: Etiologic Significance of the Elementary Bodies in Trachoma, *Am. J. Ophth.* **18**:811, 1935.

10. Thygeson, P., and Richards, P.: Nature of the Filtrable Agent of Trachoma, *Arch. Ophth.* **20**:569 (Oct.) 1938.

the role of the inclusions. In a report<sup>11</sup> read before the Fifteenth International Ophthalmologic Congress in Cairo, Egypt, in 1937 I showed that the etiologic role of the constituents of the inclusion body, the initial and the elementary body had not been satisfactorily proved from the point of view of Koch's three postulates, since elementary bodies present in trachomatous material could not be cultivated in a way which excluded all doubt. Still there are no facts which can disprove the etiologic role of the elementary body, i. e., the virus.

The newest agent which is claimed to be the causative factor in the production of trachoma was described by Busacca.<sup>12</sup> He found inclusion-like bodies in smears as well as in histologic sections of trachomatous material. According to him these bodies "appear as small granules, round or slightly elongated, sometimes isolated, sometimes joined in dumb-bell form or sometimes in masses. The characteristic dumb-bell form (all the stains do not permit one to see the small segment which unites the two granules) has a length varying from 0.5 to 0.8 micron and a width of approximately 0.2 micron. . . . In smears they stain violet-red by the Giemsa stain at  $p_H$  7.2. . . ." <sup>12d</sup> "When gathered in small heaps, they are easily differentiated from fragments of nucleus or plasma." <sup>12c</sup>

Cuénod and Nataf<sup>13</sup> since 1936 have been describing a new body which they found on the trachomatous conjunctiva. They claimed to have found rickettsias in protoplasmic fragments (so-called *plastilles*) in the follicle, in large degenerated mononuclear cells, in epithelial cells in the form of regular inclusions and in a free state. They stated that "it is difficult even with a high magnification to appreciate their exact shape

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11. Rötth, A.: Die mikrobische Aetiologie des Trachoms, abstracted, Klin. Monatsbl. f. Augenh. **100**:115, 1938.

12. Busacca, A.: (a) Reaktionen in einigen Organen von Tieren, welche mit Trachomvirus geimpft worden waren, Klin. Monatsbl. f. Augenh. **91**:277, 1933; (b) Ueber des Verhandensein von Rickettsien—ähnlichen Körperchen in den trachomatösen Geweben und über das Vorkommen von spezifischen Veränderungen in Organen von mit Trachom-Virus geimpften Tieren, Arch. f. Ophth. **133**:41, 1934; (c) Methode simple et rapide au bleu victoria pour la demonstration des Rickettsies du trachome, Folia clin. et biol. **7**:253, 1935; (d) Is Trachoma a Rickettsial Disease? Arch. Ophth. **17**:117 (Jan.) 1937.

13. (a) Cuénod, A.: Note préliminaire sur la présence d'éléments inframicrobiens dans les follicules trachomateux, Arch. d'opht. **52**:145, 1935. (b) Cuénod, A., and Nataf, R.: Deuxième note sur la présence d'éléments inframicrobiens dans les follicules trachomateux, *ibid.* **52**:573, 1935; (c) Troisième note sur l'agent bactérien du trachome, *ibid.* **53**:218, 1936; (d) Nouvelles recherches sur le trachome: Recherches expérimentales, *ibid.* **53**:355, 1936; (e) Nouvelles recherches sur le trachome: Résumé de la note préliminaire, Arch. Inst. Pasteur de Tunis **25**:295, 1936; (f) Nouvelles recherches sur le trachome, *ibid.* **26**:1, 1937; (g) Bacteriological and Experimental Researches on the Aetiology of Trachoma. Brit. J. Ophth. **21**:309, 1937.

[these dots]; they are sometimes round, sometimes ovoid, sometimes in the shape of dumb-bells, sometimes filamentous . . ." <sup>13g</sup> The dots are crowded together and glued to one another with a thick plastin, which increases their volume and makes their contour indefinite, so that they are often difficult to distinguish. Their staining properties vary, but they stain faintly.

I have given the original descriptions of these authors, as I am obliged to think, contrary to their opinion, that the bodies described by them are not the same. The morphologic difference is striking when one compares the dumb-bell, or coccoid bodies, of Busacca <sup>14</sup> with the filamentous bodies of Cuénod and Nataf. <sup>15</sup> The other great difference lies in the appearance of the bodies when crowded together within the cell. This picture alone should be characteristic, since Busacca stated that the free forms are not always identifiable and cannot be considered of great significance. This statement can also be made concerning the elementary bodies. The mass of elementary bodies is well recognizable within the epithelial cell in the form of the inclusion. But when an inclusion has burst and the elementary bodies are scattered, it is impossible to differentiate them from other extracellular granules, for instance from those of the leukocytes. As to the intracellular forms, Busacca stated that they are sometimes scattered and sometimes grouped; occasionally they may fill the cell completely. On the other hand, Cuénod and Nataf found them in cell débris, mostly glued together, whereas Busacca never made such an observation; <sup>12c</sup> furthermore, Cuénod and Nataf found these bodies in a certain number of cells within the interior of the follicles in the form of inclusions "capped by a dark hood made up of rickettsiae," agglomerated together and embedded in plastin.

Concerning the rickettsia-like bodies of Busacca, it may be that one part of these granules corresponds to the free elementary bodies. Granules of this size cannot be identified. Scrapings from persons with trachoma or with inclusion blennorrhoea may be full of such granules. However, they stain rather faint violet, not ruby red as described by Busacca. <sup>12b</sup> Occasionally I have found such red granules, for instance in material from persons with gonorrhoeal conjunctivitis (*A* in the accompanying illustration), with acute catarrhal conjunctivitis (*B*) or with chalazion (*C*). Consequently, the red granules in a free state or scattered around in the cell are not specific, although in cases of trachoma they may be the virus itself.

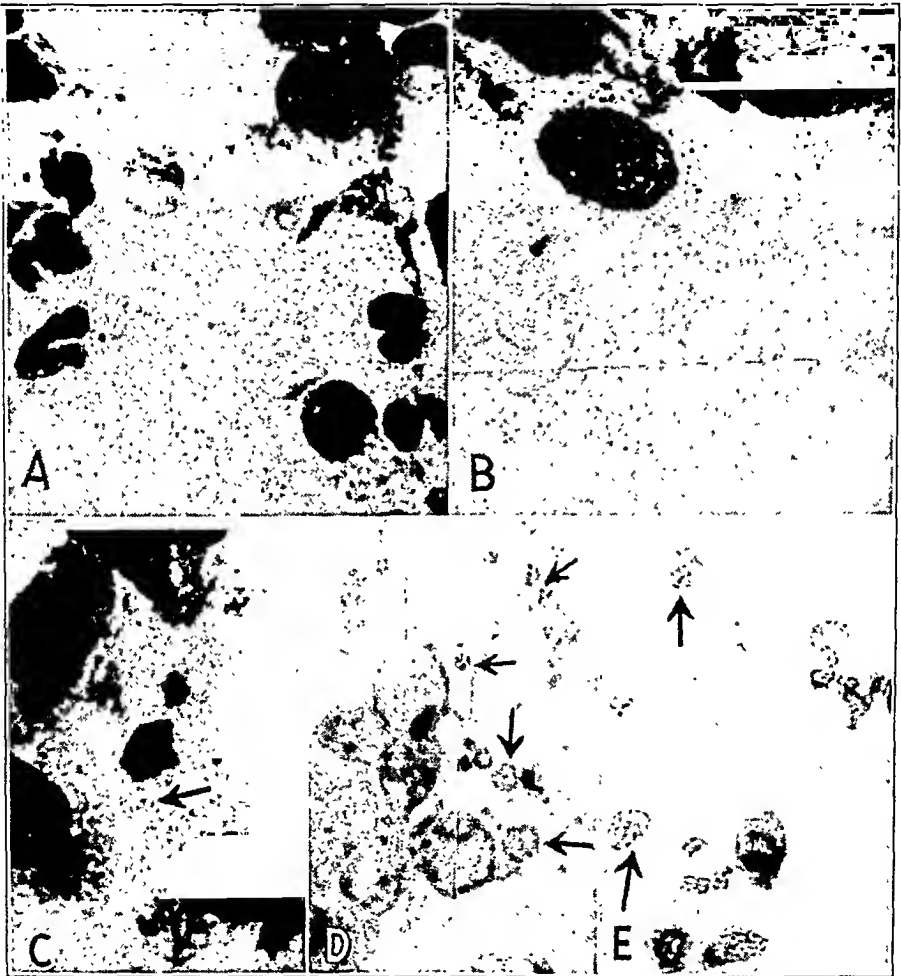
I have often seen in rickettsias of Cuénod and Nataf, i. e., the *plastilles*, especially in scraping taken after the follicles were squeezed. But such *plastilles* are a common occurrence in nontrachomatous, soft follicles also (*D* of the accompanying illustration). As to the biologic

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14. Busacca (footnotes 12 *b*, *c* and *d*).

15. Cuénod and Nataf (footnotes 13 *a*, *b*, *c* and *c*).

properties of the rickettsias, Cuénod and Nataf found the human louse to be a carrier. The anal inoculation of lice with trachomatous material causes the rapid increase of this organism. When such inoculated lice were ground up and applied to the simian conjunctiva (*Macacus inuus*) trachoma developed. These authors obtained *plastilles*, cell débris containing rickettsia-like bodies, when they inoculated infected and ground



*A*, smear of material from a patient with gonorrheal conjunctivitis. The granules stain violet red with the Giemsa stain. *B*, smear of material from a patient with acute catarrhal conjunctivitis. The granules stain violet red with the Giemsa stain. *C*, scraping taken from the conjunctival surface of a chalazion. The granules stain ruby red with the Giemsa stain. *D*, scraping obtained from a patient with a follicular conjunctivitis, showing cell débris, or *plastilles*, which stained blue with Giemsa stain. *E*, fluid from the testicles of a guinea pig, taken six days after inoculation with quartz sand, showing cell débris, or *plastilles* composed of the so-called rickettsias of Cuénod and Nataf; Giemsa stain.

up lice into the testicle of the guinea pig. However, I found them in the testicle of the guinea pig when quartz sand was used for inoculation



(E of the accompanying illustration). Furthermore, lice infected with trachoma and noninfected lice have shown no histologic difference.

Having been unable to find rickettsias in infected lice, I examined their infectivity for the monkey. Conjunctival material containing a great number of inclusions was taken from untreated persons with recent trachoma. Under slit lamp observation this material was introduced into the intestine of lice with the aid of the finest capillary pipet. From 20 to 30 per cent of the lice died in the first three days. In experiment 2 the lice were ground up and used eleven days after their inoculation; in experiments 3, 4 and 5 they were used six days after the inoculation. In experiment 1 noninfected lice were used.

#### REPORT OF EXPERIMENTS

*Experiment 1.*—A superficial abrasion was made in the conjunctiva of both the upper and the lower lid of the right eye of Pi., a 3 year old male baboon, on July 2, 1938. The conjunctiva was massaged with an emulsion prepared from eight lice ground up in 0.5 cc. of saline solution. On July 7 there was slight congestion of the lower fornix. On July 16 the same condition was noted. On July 20 and later the conjunctiva was normal.

*Experiment 2.*—The conjunctiva of the everted lids of the right eye of Ju., a 3 year old female baboon, was massaged on Nov. 15, 1938, with cotton soaked in the suspension of lice. Eight lice were ground up with quartz sand in 0.5 cc. of saline solution. The lice were infected eleven days before. On November 22 the conjunctiva was normal; it was the same on December 2 and later.

*Experiment 3.*—The conjunctiva of the everted lids of the left eye of Zu., a 4 year old female baboon, was massaged on Nov. 10, 1938, with cotton soaked in the suspension of ten lice ground up with quartz sand in 0.5 cc. of saline solution. The lice were infected six days before. On November 16 both the upper and the lower retrotarsal fold were slightly congested. On November 30 the lower retrotarsal fold showed tiny follicles but no inclusions. On December 9 and 23 the conjunctiva was normal.

*Experiment 4.*—The left eye of Te., a 4 year old female baboon, was infected on Nov. 10, 1938, in the same way and with the same material as the baboon in experiment 3. On November 12 the conjunctiva was moderately congested. On November 16 the temporal half of the lower fornix was slightly thickened. On November 23 and 30 the same condition was present. On December 6 the conjunctiva was normal.

*Experiment 5.*—The left eye of Pe., a 6 month old male *Macacus rhesus*, was infected on Nov. 10, 1938, with the same material and in the same way as the baboons in experiments 3 and 4. On November 16 and later the conjunctiva was normal.

The primary reaction to the massage of the conjunctiva was more or less marked in all baboons. Pathologic changes in the form of tiny follicles developed only in baboon 3, and these appeared twenty days after inoculation. But even these disappeared within a few days. The suspension of ground up lice contains fine solid particles. These particles

when rubbed into the conjunctiva may probably produce follicles. Cuénod and Nataf used *Macacus inuus* for their experiments. The objection cannot be made that baboons are not susceptible to trachoma. Julianelle,<sup>16</sup> reviewing all experiments concerning transmission of trachoma to animals, found that among a total of 58 baboons inoculated 29, or 50 per cent, were infected. I could not repeat the inoculation of man with infected lice, as carried out by Cuénod and Nataf. They claimed to have obtained typical trachoma, even inclusions! But they used a cyanochine stain, which is not specific for inclusions, and found "cellules épithéliales avec des noyaux chapeautés-en-blanc." This means a negative staining, which might indicate vacuolar degeneration, which often occurs in conjunctivitis. How can the clinically positive trachoma which they obtained in man be explained? I must call attention to the well known fact that the presence of follicles does not indicate trachoma. Von Szily<sup>17</sup> and Busacca<sup>18</sup> inoculated the vitreous of rabbits with trachomatous material, and follicles were produced in the uvea. This was considered a specific reaction to the trachoma virus, until Busacca also succeeded in obtaining the follicles by the injection of normal ocular tissues emulsified in glycerin. I also wish to call attention to a series of experiments in which inoculation of monkeys with *Bacterium granulosis* produced "typical trachoma"; the follicles lasted for several months and scar tissue was even found in sections. In evaluating experiments on trachoma, the nonspecificity of follicles must be kept in mind. Cuénod and Nataf inoculated a human being by means of subconjunctival injection of nineteen ground up lice. The follicles produced might have been the result of the reaction of the tissue to the minute foreign bodies and foreign protein. The natural route of infection with trachoma is certainly not by subconjunctival injection.

#### SUMMARY

The bodies found by Busacca and by Cuénod and Nataf in material from trachomatous conjunctivas, considered by them as rickettsias, are not identical. The minute bodies of Busacca could be found also in non-trachomatous conjunctival material. Such small granules, when extracellular, are not identifiable, though it may be that some of them are the specific elementary body. The rickettsias of Cuénod and Nataf are

16. For a review of all literature up to 1938, see Julianelle, L. A.: *The Etiology of Trachoma*, New York, Commonwealth Fund, Division of Publications, 1938.

17. von Szily, A.: Uebertragungsversuche mit Trachommateriel: Ein weiterer Beitrag zur Kenntnis follikelbildender Erreger, *Klin. Monatsbl. f. Augenh.* **94**:1, 1935; Trachomfollikel in der Aderhaut und im Glaskörperraum nach Uebertragung von Trachommateriel ins Augeninnere, *ibid.* **94**:320, 1935.

18. Busacca, A.: Les nodules obtenus apres inoculation intravitréenne, de matériel trachomateux sont-ils spécifiques? *Ann. d'ocul.* **173**:528, 1936.

described as polymorphic and are chiefly found in débris of cells, in which they are agglutinated. Such débris can be produced in the testicle of the guinea pig inoculated with quartz sand, and it was found also in the nontrachomatous conjunctiva. I was unsuccessful in repeating the experiments of Cuénod and Nataf, i. e., infecting monkeys with lice which were infected with trachomatous material by the anal route. The appearance of follicles does not prove the transmission of trachoma. Thus, by other means I arrive at the same conclusion reached by Thygeson<sup>19</sup> regarding the nature of "rickettsia" in trachoma.

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19. Thygeson, P.: Problem of Rickettsias in Trachoma, *Arch. Ophth.* **20**:16 (July) 1938.

## MENINGIOMA PRODUCING UNILATERAL EXOPHTHALMOS

SYNDROME OF TUMOR OF THE PTERIONAL PLAQUE ARISING FROM  
THE OUTER THIRD OF THE SPHENOID RIDGE

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The object in presenting the case reported here is to demonstrate several features of the diagnostic syndrome which have not been reported in the ophthalmologic literature. Cushing and Eisenhardt<sup>1</sup> classify meningiomas of the sphenoid ridge according to their origin from the lesser wing (*ala parva*) of the sphenoid bone or from the greater wing (*ala magna*). The lesions of the outer, or pterional, third are of two widely differing types: (1) the flat, spreading tumor (*meningioma en plaque*) which provokes hyperostosis, chiefly of the greater wing of the sphenoid bone, and (2) the large spherical tumor (*meningioma global*) which expands within the crotch of the sylvian fissure. Why the *meningioma en plaque* favors the outer third of the ridge and induces bony overgrowth is not known. Associated factors thought to be related are that the bone of the *ala magna* is highly vascular, the adjacent dura extremely thick and the leptomeningeal villi abundant.

Cushing cited 16 surgically verified cases and 3 clinically unmistakable cases of tumor of the pterional plaque with characteristic clinical signs and symptoms. All of his patients were women averaging 49 years of age on admission in whom slowly increasing painless, unilateral exophthalmos (nonpulsating and irreducible) had been present for two to ten years. The globe was displaced downward, and some puffiness of the lids was present on the patient's arising. Next in appearance were a palpable suprazygomatic swelling and some tenderness on pressure in the overlying temporal muscle (fig. 1). Roentgenograms confirmed

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Read before the Section of Ophthalmology of the New York Academy of Medicine, Jan. 16, 1939.

From the Department of Ophthalmology, New York Post-Graduate Medical School and Hospital, Columbia University.

1. Cushing, H., and Eisenhardt, L.: *Meningiomas: Their Classification, Regional Behavior, Life History, and Surgical End Results*, Springfield, Ill., Charles C. Thomas, Publisher, 1938. (This is a volume of 785 pages, with a comprehensive bibliography.)

the diagnosis suggested by the exophthalmos and suprazygomatic fulness. The characteristic findings in lateral views stereoscopically were thickening in the line of the orbital roof, which extended from the flare at the pterion along the sphenoid ridge, sometimes so far inward as to involve the anterior clinoid process; involvement of the floor of the middle fossa which was variable in its thickness and extent, and also thickening of the greater wing of the sphenoid bone composing



Fig. 1.—Photographs of 12 patients cited in Cushing and Eisenhardt's monograph, "Meningiomas." The second patient (top row, reading from left to right) had deep-set eyes and small globes. Note how the temporal, or suprazygomatic, fulness is concealed by the hairdressing of the patient.

(Published by courtesy of Charles C. Thomas, Publisher, Springfield, Ill.)

the outer wall of the orbit. The anterior-posterior views demonstrated the extent of involvement of the lateral orbital wall and the degree of encroachment on the superior orbital fissure.

The tumor grows slowly, never invades the brain and does not produce intracranial hypertension. The lesion may be assumed to be

of several or more years' duration before protrusion of the globe is first noticed. Cerebral symptoms occur late in the progress of the disease. Palsy of the ocular muscles, defects in the visual fields, choked disks and atrophy of the optic nerve develop, respectively, as the orbital plates become thickened or encroach on the optic nerve or on the foramen or as the tumor extends into the orbit.<sup>2</sup> Complications in the case in which diagnosis has not been made are progressive exophthalmos necessitating enucleation, atrophy of the optic nerve and further infiltration of the hyperostosed bone, so that the tumor may pass through the zygomatic fossa and actually infiltrate the temporal muscle outside the skull.



Fig. 2.—Exophthalmos of the left eye measuring 7 mm. Suprazygomatic fullness was apparent only when the hair was raised off the temple.

#### REPORT OF A CASE

N. N., a 53 year old woman, was first seen on April 15, 1938 (fig. 2). She noted that the left eye became prominent about nine months previously. During the month preceding examination lacrimation was the only symptom present. When she was first examined by her physician the possibility of thyroid disease was considered, but the basal metabolic rate was found to be normal. Vision in the left eye was 20/20, and an exophthalmos of 7 mm. was present. The eyeball was displaced downward. The left pupil measured 0.5 mm. more than the right, and the reaction to light was slightly less than normal. In the eyeground the only variation from normal was a mild engorgement and dilatation of the superior

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2. Voris, H. C., and Adson, A. W.: Meningiomas of the Sphenoidal Ridge with Unilateral Exophthalmos: Report of Two Cases, *S. Clin. North America* **14**: 663 (June) 1934.

temporal vein. No bruit was heard over the globe or temporal fossa, and no mass was palpable in the orbit. There was a slight limitation of movement of the left superior rectus muscle. The field of vision was normal. Slight fulness was noted beyond the tip of the left eyebrow. Examination of the right eye gave negative results, and vision was 20/20—.

A tentative diagnosis was made of a mass in the left orbit. The roentgenographic report on a flat plate stated that a circular, sharply outlined dense shadow, believed to be that of a tumor mass lay behind the orbit. On request, stereograms were taken, and according to the report the previously seen shadow was again shown situated between the posterior wall of the left orbit and the anterior wall of the sphenoid bone. Fortunately, Dr. S. Fineman's opinion was sought on these plates, and though their detail was not clear, the intracranial process was extensive

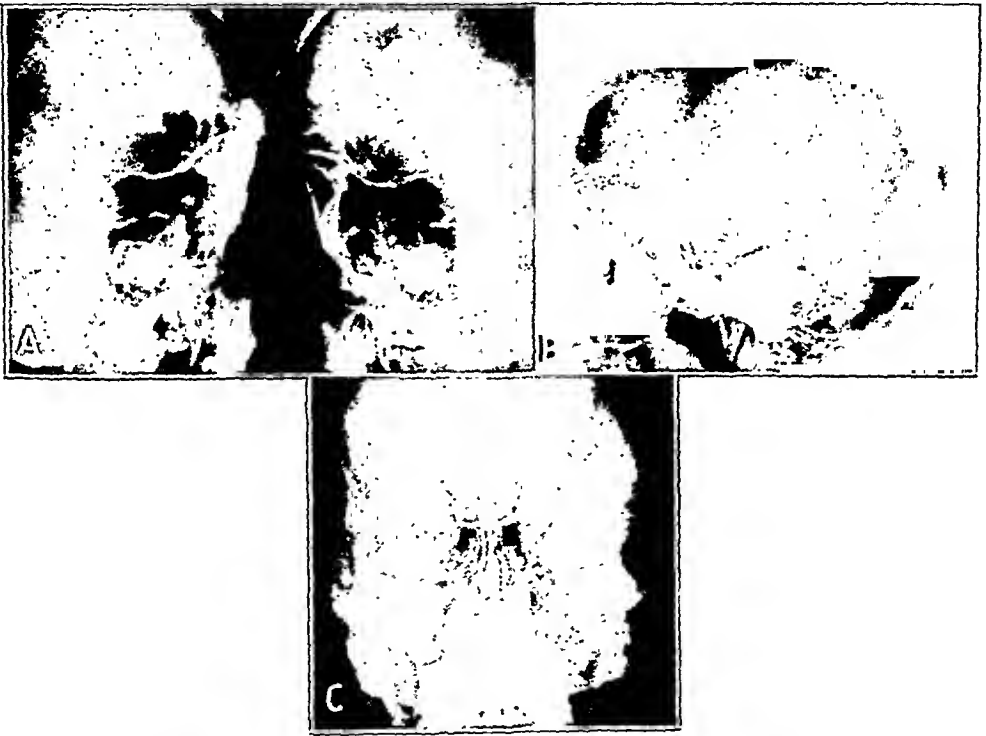


Fig. 3.—*A*, posterior-anterior view of the orbit, showing hyperostosis of the greater and lesser wings of the sphenoid extending laterally and superiorly into the pterional region. *B*, lateral view of the skull, showing hyperostosis of the sphenoid ridge. *C*, view showing the optic foramina. The left foramen is of normal contour and density. Hyperostosis is shown extending from the pterional region involving the sphenoid ridge to the lateral edge of the foramen.

enough to warrant the provisional diagnosis of meningioma of the sphenoid ridge. Subsequent roentgenograms made by Dr. Fineman were reported on as follows:

The stereoscopic examination of the skull revealed a flat and dense area of hyperostosis involving the left sphenoid ridge, the greater and lesser wings of the sphenoid bone, the roof of the orbit and the region where the frontal and parietal bones articulate with the greater wing of the sphenoid (fig. 3). Excessive vascularization or evidence of proliferative changes in the form of spicule formation was not apparent in the outer plates of the cranial bones at the site of this lesion. The optic foramen of the left side did not show encroachment of its lumen by the hyperostotic process, which was involving the lesser wing of the sphenoid bone

in the region of the foramen. Study of the sella turcica showed considerable decalcification of the posterior clinoid processes. The clinoid processes, however, as well as the base of the sella turcica were intact, and the sella did not appear to be enlarged.

Study of the remainder of the cranium showed a moderate degree of decalcification through the cranial bones. The pineal body was calcified, but other intracranial calcific deposits were not apparent. The vascular channels appeared to be within normal size and distribution.

The facial bones did not show any hyperostotic changes. The sphenoid, frontal, ethmoid and maxillary sinuses appeared to be clear.

The foregoing changes were considered indicative of the presence of a meningioma in the region of the hyperostotic changes described. The same changes were noted in a series of roentgenograms taken at the New York Post-Graduate Medical School and Hospital.

General medical examination by Dr. C. Dary Dunham gave negative results.

Neurologic examination at the hospital on May 10 by Dr. George A. Blakeslee revealed a normal gait but suppressed autonomic associated movement in the right arm. The Romberg sign was negative. Coordination in the extremities was normal. There was exophthalmos of the left eyeball, and the pupil was slightly wider than the right. The fundi were normal. Hearing and smell were normal. There was slight drooping of the right corner of the mouth. The right nasolabial fold was slightly shallower than the left. The tongue protruded in the midline. The deep biceps, triceps, patellar and achilles reflexes all were hyperactive, but the right patellar and right suprapatellar reflexes were less active than the left. The right abdominal reflexes were less active than the left. There was a plantar reflex on the left side. A questionable Babinski sign was present on the right side; there was dorsiflexion of the large toe at times but no plantar flexion at any time. General sensory examination gave negative results. The findings indicated slight pressure in the left cerebral hemisphere, giving rise to organic signs of involvement of the upper motor neuron. The neurologic and roentgenographic examinations confirmed the diagnosis of meningioma of the left sphenoid ridge.

The progressive ocular changes noted when the patient was last examined on December 20 were exophthalmos of 8 mm., a palpebral fissure that was 0.5 mm. wider, and the visual field was contracted 10 degrees temporally and 10 degrees superiorly. Vision was 20/20, and the fundus was unchanged.

Dr. Leo M. Davidoff was consulted for his neurosurgical opinion. He recommended operation, as the patient's physical condition was good and by temporal palpation the tumor seemed relatively small. The chances were considered about even for complete removal at this time. Two or three years later the eye would be damaged and the osseous involvement too extensive to permit satisfactory removal. The patient was to undergo operation the next month.

#### COMMENT

Unilateral exophthalmos is not a common finding in cases of tumor of the brain. Its occurrence was noted only 15 times in 807 verified intracranial neoplasms reported by Elsberg, Hare and Dyke.<sup>3</sup> However,

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3. Elsberg, C. A.; Hare, C. C., and Dyke, C. G.: Unilateral Exophthalmos in Intracranial Tumors with Special Reference to Its Occurrence in the Meningiomata, Surg., Gynec. & Obst. 55:681 (Dec.) 1932.



in 10 of the 15 cases meningeal tumors were present. Recently Cohen and Scarff<sup>4</sup> and Arnold Knapp<sup>5</sup> reported meningiomas from the ophthalmologic standpoint. In a study of 82 consecutive patients with unilateral exophthalmos O'Brien and Leinfelder<sup>6</sup> observed in a group of 10 benign neoplasms 3 meningiomas of the sphenoid ridge. Hyperostosis of the orbit resulting from tumor of the pterional plaque is a relatively frequent cause of slowly progressive noninflammatory exophthalmos.

Of the 15 cases of proptosis in Elsberg's series, the tumor showed a predilection for the left side in females (7 of 8) and for the right side in males (5 of 7). In Cushing's 16 cases the incidence was the same on the right and left. Knapp's 2 cases and the 1 reported here occurred in women and on the left side. In a personal communication Cushing stated: "It is curious that most of these hyperostosing pterional lesions appear to be in women and on the left side. The same is true of the lateral meningiomas of the velum, so-called intraventricular meningiomas. I have no explanation to offer for it whatsoever."<sup>7</sup> The occurrence in males has been observed by Stender,<sup>8</sup> Penfield<sup>9</sup> (2 cases) and by Cohen and Scarff. Unless the ophthalmologist who is first consulted by the patient for the exophthalmos suspects the lesion early, complete removal is impossible, and the neurosurgeon is confronted with a formidable problem. The Kronlein operation is unwarranted in the light of the knowledge of the intracranial source of the growth. Cushing reported 3 recurrences locally necessitating secondary operations sixteen, five and eight years, respectively, after the first operation, and 1 operative fatality, representing a case mortality of 6.25 per cent. Occasionally cases are encountered in which the exophthalmos remains almost stationary for many years, the vision unimpaired and clinical symptoms so slight that operation may be safely postponed.

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4. Cohen, M., and Scarff, J. E.: Unilateral Exophthalmos Produced by a Meningioma of the Middle Cranial Fossa: Report of a Case, *Arch. Ophth.* **13**: 771 (May) 1935.

5. Knapp, A.: Orbital Hyperostosis: Its Occurrence in Two Cases of Meningioma of the Skull, *Arch. Ophth.* **20**:996 (Dec.) 1938.

6. O'Brien, C. S., and Leinfelder, P. J.: Unilateral Exophthalmos: Etiologic and Diagnostic Studies in Eighty-Two Consecutive Cases, *Am. J. Ophth.* **18**: 123 (Feb.) 1935.

7. Cushing, H.: Personal communication to the author.

8. Stender, A.: Ueber das Meningiom des Keilbeinrückens, *Ztschr. f. d. ges. Neurol. u. Psychiat.* **147**:244, 1933.

9. Penfield, W.: Cranial and Intracranial Endotheliomata-Hemicraniosis, *Surg., Gynec. & Obst.* **36**:657 (May) 1923.

## SUMMARY

An early case of meningioma is presented before operation, arising from the outer third of the sphenoid ridge.

The syndrome of pterional meningioma en plaque consists of (1) slowly progressive, painless, nonpulsating unilateral exophthalmos; (2) normal vision, fields and eyegrounds; (3) suprazygomatic fulness; (4) roentgen findings of hyperostosis involving the sphenoid ridge, the greater and lesser wings of the sphenoid bone, the roof of the orbit and the area where the frontal and parietal bones articulate with the greater wing of the sphenoid bone (pterional region); (5) occurrence usually in a female of middle age, and (6) greater incidence of the tumor on the left side.

Early recognition and neurosurgical operation offers a favorable possibility of retaining useful vision and arrest or even recession of the exophthalmos.

NOTE.—On Feb. 6, 1939, Dr. Leo M. Davidoff excised the left frontotemporal bony hyperostosis and removed the pterional meningioma en plaque, using local anesthesia. The description of the operation follows:

A low lateral frontotemporal flap was outlined covering the hyperostotic area, as demonstrated in the roentgenogram. The making of the flap was unaccompanied by any difficulty, except in the elevation, which was extremely difficult to accomplish because a part of the hyperostosis resulting from the tumor had to be broken across. This was eventually accomplished, and as soon as the flap was raised sharp bleeding occurred from the region of the middle meningeal artery, which was controlled by digital compression until the vessel could be visualized by sucking away the blood and the bleeding controlled by the application of cautery and silver clips. The portion of the hyperostosis on the flap side of the bone was then excised. This was easily accomplished by cutting part of the way around it with the de Vilbis forceps and completing the removal with the Gigli saw. Next to receive attention was the marked hyperostosis of the base of the skull and the wings of the sphenoid bone. This was attacked by means of drilling holes into the bone in order to make it thinner and piecemeal removal of the hyperostosis. By this method, it was possible to decompress the orbit and to excise the greater portion of the hyperostosis, leaving only the mesial part which extended along the wing of the sphenoid bone to the anterior clinoid process. When all the bone that could possibly be removed had been taken away, the dura was incised, and in a few minutes a flat intradural tumor not more than 3 mm. in thickness at its thickest portion and about 3 cm. in diameter was excised together with the dura to which it was adherent. The most inferior portion of the tumor did not come away in one piece with this removal, and what remained of it was completely charred by means of the cautery and the charred tissue excised by the electric loop. I believe that the whole soft tumor tissue was removed and approximately seven eighths of the bony hyperostosis. After this, hemostasis was carried out, and the flap closed in the usual manner after a split rubber tube drain was placed external to the dura. The large defect in the dura was not closed. There was a considerable amount of hemorrhage, but it was never out of control. The patient withstood the procedure extremely well under local anesthesia. At no time was there any serious drop in her



Fig. 5.—Invasion of the skull by a meningioma. Section showing small groups of whorls in the marrow spaces of the diploe;  $\times 50$ .

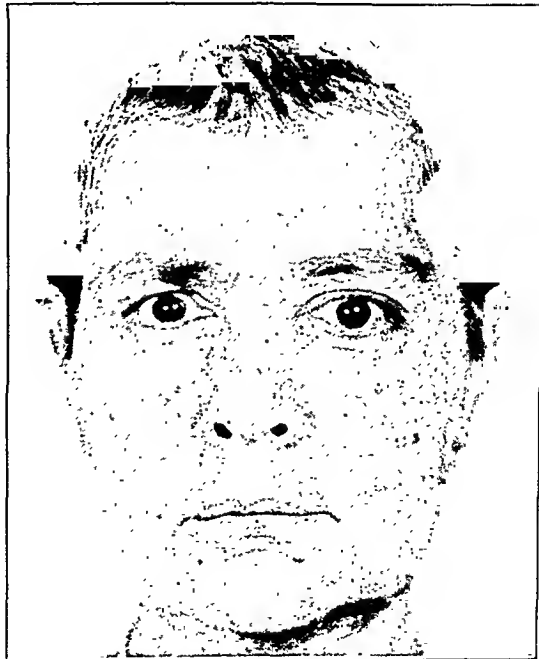


Fig. 6.—Patient two months after operation, showing a 2 mm. recession of the exophthalmos and a scar of the frontotemporal incision.

of well formed blood vessels were present. In some areas there was a tendency toward concentric arrangement of tumor cells, suggesting whorls. Sheets of tumor cells had invaded the dura and extended to its outermost surface. Mitotic figures and giant cells did not occur, and there was no intercellular material (fig. 4).

Sections through the bone revealed thick bony trabeculae with considerable fibrous marrow. Nests of tumor cells which varied from round or cuboidal to elongated forms were present within the haversian canals. Areas of calcification and irregular trabeculae of bone were present within some of the bone spaces. One could not be certain that the tumor cells were themselves laying down new bone (fig. 5).

The diagnosis was meningioma, meningiotheliomatous with hyperostosis.

When the patient was last examined on April 8 vision in the left eye was 20/20, the field of vision was contracted 10 degrees temporally as previously reported preoperatively and instead of the suprazygomatic fulness a depression was noted. The left exophthalmos had receded 2 mm. (fig. 6).

1016 Fifth Avenue.

# SUŚRUTA AND HIS OPHTHALMIC OPERATIONS

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SONPUR STATE, SONPUR RAJ, INDIA

Suśruta,<sup>1</sup> the world's first surgeon, was the son of the great sage Viśwāmitra<sup>2</sup> of Ancient India and the most prominent of the pupils of Dhanwantari,<sup>3</sup> "the Father of Indian Medicine." He lived in Hindustan thousands of years before Christ and long before the Hippocratic Age and was the first to practice and teach the principles of surgery.

Credit is due those distinguished Western scholars, such as Schultze,<sup>4</sup> Royle,<sup>5</sup> Wilson,<sup>6</sup> Müller,<sup>7</sup> Heins,<sup>8</sup> Johnston-Saint,<sup>9</sup> Wise,<sup>10</sup> Macdonnell,<sup>11</sup> Hoernle<sup>12</sup> and Green-Armytage,<sup>13</sup> who have made thorough investigation and research into the ancient medical works of the Hindus and have declared unanimously that India is the birthplace of medicine. Credit is also due Thakore Sahib of Gondal, Maharaja Sir Bhagvat Simhajee,<sup>14</sup> Mukherjee,<sup>15</sup> Bhisagratna,<sup>16</sup> Roy,<sup>17</sup> Dutt<sup>18</sup> and a

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1. Suśruta Samhitā, with Dallana Acharya's Commentary, edited by Yādava Sharma, ed. 2, Bombay, Nirnaya-Sagar Press, 1931, Sūtrasthāna, chap 1.

2. Suśruta Samhitā,<sup>1</sup> Uttara Tantra, vol. 2, chap. 18, verse 2.

3. Dhanwantari, cited in Suśruta Samhitā.<sup>1</sup>

4. Schultze, J. H.: *Historia medicinae a rerum initio ad annum urbis Romae dxxxv deducta*, Lipsiae, P. C. Monath, 1728.

5. Royle, J. F.: *An Essay on the Antiquity of Hindoo Medicine, Including an Introductory Lecture to the Course of Materia Medica and Therapeutics*, London, W. H. Allen & Co., 1837.

6. Wilson, H. H.: *On the Medical and Surgical Sciences of the Hindus*, *Orient. Mag.* 1:207 and 349, 1823.

7. Müller, M.: *Works on Hindu Medicine*.

8. Heins: *Tracts of India*, London, 1814.

9. Johnston-Saint, P.: *An Outline of the History of Medicine in India*, *Indian M. Rec.* 49:289, 1929.

10. Wise, T. A.: *Commentary on the Hindu System of Medicine*, Calcutta, Thacker & Co., 1845.

11. Macdonnell, A. A.: *History of Sanskrit Literature*, New York, Daniel Appleton & Co., 1900.

12. Hoernle, A. F. R.: *Studies in the Medicine of Ancient India: I. Osteology of the Bones of the Human Body*, Oxford, Clarendon Press, 1907, p. ix.

13. Green-Armytage, V. B.: *Debt of Western Medicine to the East* (Twenty-Sixth Long Fox Memorial Lecture), *Bristol Med.-Chir. J.* 54:239, 1937.

14. Bhagvat Simhajee: *History of Aryan Medical Science*, ed. 2, New York, The Macmillan Company, 1927.

(Footnotes continued on next page)

host of others who have taken great pains to study the medical science of the Hindus and have established its greatness and preeminence.

It is instructive and interesting to read the verdicts of those Western scholars on the merits of the medical works of the Hindus and on the merits of Suśrutian surgery.

Royle for the first time proved beyond doubt the great antiquity of Hindu medicine and established its right position in the history of science.<sup>19</sup>

According to Macdonnell<sup>20</sup>:

It is acknowledged by many Western writers that the system of Hindu medicine had considerable influence on the development of medicine in Europe. The works of Charaka and Suśruta, the two greatest Sanskrit authorities, were rendered into Arabic at the close of the eighth century A.D. and are quoted as authority by the celebrated Arabic physician Al Rhazes, who died in 932 A.D. Arabic medicine in its turn became down to the seventeenth century the chief authority for European physicians, and Charaka is frequently mentioned in Latin translations of Arabic writers.

Wise is the pioneer of systematic research in the field of study of Hindu medicine, and his sympathetic appreciation of the Hindu system of medicine will always be remembered with gratitude by my countrymen.<sup>19</sup>

Johnston-Saint<sup>9</sup> stated:

In Arabic medicine, in Greek medicine, in what we know of Ancient Egyptian medicine, we find time after time traces of what can only be derived from the even more ancient and famous Indian medicine. So the parent of modern medicine is not Greece but India.

Green-Armytage,<sup>13</sup> in an inspiring address, said:

Hitherto it has been the pride and fashion of scholars to ascribe to the ancient Greeks the glory of having first conveyed in their own language the foundations of Medicine, Philosophy and Art; but recent research has shown that the genius of the Greeks drew its sap from Phœnicia and Crete, from Babylon and Egypt, and even still farther afield from Sumeria and the dwellers in the Valley of the Indus. Indeed, it was from the East and not from Egypt that Greece derived her architecture, her sculpture, her science, her philosophy, her mathematical knowledge—in a word, her intellectual stimulus.

15. Mukherjee, G. N.: *Surgical Instruments of the Hindus*, Calcutta, Calcutta University, 1913, vol. 1.

16. Bhiśagrata, Kaviraj K. L.: *Suśhruta Samhitā*, English translation, Calcutta, The Translator, 1907-1916, vols. 1, 2 and 3.

17. Roy, A. T.: *Medical Science in India*, *Indian M. Gaz.* 64:414, 1929; *Peep into Ancient Medicine*, *Indian M. Rec.* 49:357, 1929.

18. Dutt, U. C.: *The Materia Medica of the Hindus*, Compiled from Sanskrit Medical Works, Calcutta, Thacker, Spink & Co., 1877.

19. Mukherjee,<sup>15</sup> p. xv.

20. Macdonnell,<sup>11</sup> chap. 6.

Speaking about Suśruta, he stated:

Suśruta taught that the foundation of surgery was anatomy, and made his pupils do dissections. . . .

Thus began the golden age of Hindu surgery. To Suśruta we owe the discovery of cataract-couching, skin-grafting and rhinoplasty. From him we possess a precise knowledge of midwifery and learn the positions occupied by the foetus *in utero*. . . . He speaks of post-mortem Cæsarean section. He writes of amputations and the necessity of artificial limbs made of iron. Tumours are removed, ruptures reduced and patients cut for stone. Still more remarkable are the rules laid down for the operating room, for it is written that it should be fumigated with sweet vapours, the surgeon is to keep his hair and beard short, nails clean and wear a sweet-smelling dress. It is not certain what drug was used, but directions are given that the patient was to inhale a substance called *somnolini* [anesthetic] before operation. Over a hundred steel instruments are depicted and their uses described. Many of these have their counterparts in the catalogues of every modern firm supplying the needs of the general surgeon.

Such was Suśruta, a great surgical genius of Ancient India, who practiced and taught the principles of surgery at the dawn of civilization.

According to Simhajee <sup>21</sup>:

The work of Suśruta was translated into Arabic at the end of the eighth century A.D. It has been translated into Latin by Hessler and German by Vullers. The Latin translations formed the basis of European medicine, which remained indebted to the Eastern Science of Medicine down to the seventeenth century.

In Mukherjee's work it is stated <sup>22</sup>:

The Arabic version of Suśruta Samhitā is called "Kitabe-Shawshoonal-Hindi" and is also mentioned as "Kitabi-Susrud" by Abillsaibial. Rhazes often quotes Sarad as an authority on surgery.

Suśruta-Samhitā, written by Suśruta in chaste classical Sanskrit, furnishes the earliest records of the description of diseases of the eyes and their treatment.

Mukherjee <sup>23</sup> stated:

The age of Suśruta is involved in obscurity. Nothing can be ascertained from the fact that he was a son of Viśwāmitra, for the age in which the latter flourished is not known to us. But he must have flourished during the Vedic Age, as many Vedic hymns are ascribed to him. In the Mahābhārata, <sup>24</sup> Suśruta is mentioned as one of the sons of Viśwāmitra, and in the Suśruta-Samhitā, the author is referred to as his son. The age of the great epic has with good reasons been fixed at 1000 B.C. So Suśruta must have flourished earlier.

Suśruta was the first Ayurvedic surgeon to deal systematically, and most exhaustively and elaborately, with the development and the ana-

21. Bhagvat Simhajee, <sup>14</sup> p. 196.

22. Mukherjee, <sup>15</sup> vol. 1, pp. 17-18.

23. Mukherjee, <sup>15</sup> chap. 1, pp. 14-15.

24. Vyāsa: Mahābhārata, book 13 (Anuśāsana Parva), chap. 4.

tomic structure of the eye and the physiologic factors, the pathologic changes, the symptoms and the treatment of ocular diseases. His ophthalmic works have been incorporated in the Uttara Tantra of Suśruta Samhitā, chapters 1 to 19. He described the diseases of the eyelids, conjunctiva, sclera, cornea, uveal tract, lens, retina and vitreous, and glaucoma. He was the first ophthalmic surgeon to do the classic cataract operation of lens couching. Suśruta's description of *arman* (pterygium) is most elaborate. He described five varieties of pterygium, while most modern ophthalmologists give four varieties. His surgical treatment for pterygium is as perfect as, but perhaps more elaborate than, any modern ophthalmic operation. His surgical treatment for *pakśma-kopa* (trichiasis) may well be compared with the Jaesche-Arlt operation.<sup>25</sup> His views regarding the prognosis of the various ocular diseases, viz., uveitis (*adhimantha*) and glaucoma (*gambhīrikā*), to mention only a few, stand unaltered today as he taught them many thousands of years before Christ.

Bhīśagrata<sup>26</sup> aptly remarked :

Of the 76 varieties of ophthalmic diseases Suśruta holds that 51 are surgical. The mode of operation which is to be performed in each case has been elaborately described in the Samhitā and does not unfavourably compare in most instances with modern methods of ophthalmic surgery. Suśruta was aware of the fact that the angle of reflection is equal to the angle of incidence and that the same ray which impinges upon the retina serves the double purpose of illuminating the eye and the external world and is in itself converted into the sensation of light.

Suśruta's ocular therapy is most exhaustive, and the modern ophthalmologist will learn a great deal from it. To give a few examples, Suśruta was the first to use breast milk<sup>27</sup> as a hemostatic, nutritive and soothing agent in ocular therapy. *Dāru-haridrā* (*berberis asiatica*<sup>28</sup>) and *rasānjana* (extract of *Berberis asiatica*) were first used by him. He described many ophthalmic instruments, and he was the first surgeon to introduce the use of bandages and suturing with horsehair.

His technics for scarification (*lekhaṇa*), excision (*chhedana*), incision (*bhedana*) and venesection (*vyadhana*) stand comparison with any of the modern methods of operative treatment.

Before describing the ophthalmic operations of Suśruta, it will be worth while to have a bird's-eye view of his description of the anatomic structure of the eye and his classification and definition of the various ocular diseases known to him.

25. May, C. H., and Worth, C.: A Manual of the Diseases of the Eye, ed. 5, London, Baillière, Tindall & Cox, 1927, chap. 4, p. 46.

26. Bhīśagrata,<sup>16</sup> vol. 1.

27. Suśruta Samhitā,<sup>1</sup> Uttara Tantra, chap. 17, verse 61.

28. Suśruta Samhitā,<sup>1</sup> Uttara Tantra, chap. 12, verses 13 and 14.



In chapter 1 of Uttara Tantra Suśruta described the development and the anatomic structure of the eye and dealt with the physiologic factors, the pathologic changes, the premonitory symptoms and the causes of ocular diseases in general.<sup>29</sup>

#### ANATOMIC STRUCTURE OF EYE

Suśruta, quoting Dhanwantari's opinion, stated that the sense organ "eye" is developed (simultaneously with other sense organs) from the cephalic<sup>30</sup> portion of the fetus.

According to the Rigveda,<sup>31</sup> the eyes of the child, which originated in the cephalic portion of the fetal body, develop first. The factors which are essential to the development of the fetal body from the time of fecundation to the appearance of the characteristic sense organs are also described.

The anatomic structure of the eye, as described by Suśruta, is given briefly as follows: The eyeball (*nayana-bud-buda*) is of the size of 2 fingers in transverse diameter, about the breadth of a thumb in sagittal diameter and the size of 2½ fingers in circumference. The eyeball is almost round and resembles the teat of a cow (*gō-stonākāra*). The black outline constitutes one third of the area of the whole eye and the pupil one seventh of the area of the black outline. There are five *mandalas* (circles), six *sandhis* (junctions) and six *patalas* (layers or coats) of the eye.

The five *mandalas* (circles or regions) are as follows: (1) *pakśma-mandala*, the circle of the eyelashes; (2) *vartma-mandala*, the circle of the eyelids; (3) *śveta-mandala*, the white or sclerotic region; (4) *kṛṣṇa-mandala*, the black circle or cornea, and (5) *dṛiṣṭi-māṇḍala*, the pupillary or visual circle. The *mandalas* are so arranged that each succeeding one lies within the one preceding it; viz., the pupillary circle lies within the black circle and the black circle within the white circle and so on.

The six *sandhis* (junctions, lines of demarcation of the *mandalas* or circles) are described as follows: The first *sandhi* joins the eyelashes with the eyelids; the second, the eyelids with the sclerotic region; the third, the sclera with the black outline (cornea), and the fourth, the black outline with the pupillary region. The fifth *sandhi* lies in the mesial angle of the eye (*kaninikā*) and the sixth in the external corner (*apāṅga*) of the eye.

The six *patalas* (layers or coats) consist of two in the eyelid (*vartma-mandala*) and four in the eyeball. Of those in the eyeball, the first one (the anterior *patala*) supports the *jala* (aqueous

29. Suśruta Samhitā,<sup>1</sup> Uttara Tantra, chap. 1, verses 1-45.

30. Suśruta Samhitā,<sup>1</sup> Sharira Sthāna, chap. 3, verse 18.

31. Rigveda Samhitā,<sup>10</sup> mandala, 184 sukta.

humor) and *tejas* (light-refracting medium); the 'second consists of muscles (ciliary region); the third consists of gelatin and fat (*medas*)—vitreous—and the fourth constitutes the retina. There are divisions and subdivisions of these coats.

The different parts of the eyeball are held together by vessels and muscles. The eyeball is held in the orbit by a mass of *ślesmā* (capsule of Tenon) supported by a number of vessels.

According to Suśruta, the intraocular and bodily humors become deranged and unhinged by the following causes and bring about disorders of the organ of vision:

Diving in water immediately after being exposed to heat and glare of sun; prolonged gazing at distant objects; sleeping during the day and waking up late at night; continued excessive weeping, over-indulgence in grief and rage; bodily shock or injury, indulgence in sexual excesses; partaking of fermented rice-water, acid gruel, *Māśa* pulse (*Phaseolus raditus*) and *Kulatha* pulse (*Dolichos biflorus*); voluntary repression of natural urgings; exposing the eye to smoke and dust; trickling of sweat into eyes; excessive or suppressed vomiting; suppression of tears; constant and repeated contractions of the eyes to adjust the sight to accommodate small objects, etc.

#### DESCRIPTION OF OCULAR DISEASES

Predisposing signs and symptoms of ocular diseases include cloudiness of vision, slight inflammation, lacrimation, accumulation of mucus, heaviness, burning sensation, sucking pain and redness of the eyes. In case of inflammation of the eyelids the eye feels as if it were studded with bristles; there is a pricking pain, and the patient is conscious of an impairment in the faculty of discerning colors and in the normal closing and opening of the eyelids.

An intelligent physician will conclude from these symptoms that the eyes have become diseased due to derangement of the intraocular and bodily humors.

According to Suśruta's principles of treatment, the simple maxim to be followed is to avoid and guard against the primary factors predisposing to the disease. Special exhaustive remedial measures should be employed to pacify the bodily humors and to combat the concomitant complications.

The localities of the seventy-six varieties of ocular diseases are classified by Suśruta<sup>32</sup> as follows: Nine are confined to the *sandhis* (junctions); twenty-one are diseases of the *vartma-mandala* (eyelids) and *pakśma-mandala* (eyelashes); eleven are diseases of the *śukla-mandala*<sup>33</sup> (sclera); four are diseases of the *krisna-mandala* (black

32. Suśruta Samhitā,<sup>1</sup> Uttara Tantra, chap. 1.

33. Suśruta Samhitā,<sup>1</sup> Uttara Tantra, chap. 2.

circle); seventeen affect the whole eye; twelve are diseases of the visual apparatus, lens, retina, etc., and two are diseases of traumatic origin.

Definitions of the nine diseases of the *sandhis*<sup>33</sup> follow:

1. *Puṣyālasa* (dacryocystitis)—a swelling at the *sandhi* (junction) of *kāminikā* (the mesial angle of the eye) from which exudes fetid and dense pus.

2. *Upanāha* (a cystic growth near the limbus)—a slightly painful cyst (*granthi*) of considerable size at the *sandhi* (junction) of the pupil with the black circle, attended with an itching sensation and a little suppuration.

Diseases of the lacrimal ducts give rise to a profuse discharge. These ducts terminate in fistulas and produce secretion. Suśruta wisely described four kinds of *srāvas* or lacrimal fistulas.

3. *Puṣya-srāva* (lacrimal fistula with a purulent discharge)—a suppuration in any of the *sandhis* (junctions) of the eye marked by a discharge of pus.

4. *Ślesmā-srāva* (lymphatic exudation)—secretion of slimy, white, thick mucopurulent discharge marked by absence of pain.

5. *Rakta-srāva*—a discharge of thin, blood-stained, copious secretion, due to the derangement of the blood.

6. *Pitta-srāva*—a warm, watery yellowish discharge from the middle part of the *sandhi* (junction), due to derangement of the biliary function.

7. *Parvanikā* (phlyctenule?)—a small, copper-colored swelling at the junction of the black circle with the white circle (limbus), due to the vitiated state of the local blood.

8. *Alaji* (a larger phlyctenule?)—a swelling with the characteristics of the *parvanikā* but comparatively larger.

9. *Krimi-granthi* (parasitic cyst; myiasis)—a nodule (*granthi*) appearing at the junction of the eyelid and the eyelashes and characterized by an itching sensation. Parasites of different species are found to infest the region where the inner lining of the eyelid is connected with the sclerotic coat of the eye and to invade and vitiate the tissue of the eyeball.

Definitions of the twenty-one diseases of the *vartma-mandala*<sup>34</sup> and the *pakśma-mandala* follow:

1. *Utsangini* (hordeolum or styne)—an indented boil or eruption (*pidakā*) occurring along the exterior of the lower eyelid with its mouth projecting inward.

2. *Kumbhakini* (infarcts of the meibomian glands or chalazion)—boils or pustules the size of *kumbhikā* (pistia stratiotes) which appear at the junction of the eyelid and the eyelashes, and rupture of which is followed by inflammation.

3. *Pōthaki* (follicular conjunctivitis)—a number of red, heavy papules resembling red mustard seeds, attended with pain, itching and exudation.

4. *Vartmaśarkarā* (ulcerative pustular conjunctivitis)—a rough, large pustule surrounded by small, thick erythematous pustules covering the entire surface of the eyelid.

5. *Arso-vartma* (trachoma?)—vegetations of small, rough papillae on the eyelid, attended with little pain.

6. *Suskarśas* (granular conjunctivitis)—long, rough, hard, numbed papillae (*ankura*) on the eyelid.

34. Suśruta Samhitā,<sup>1</sup> Uttara Tantra, chap. 3.

7. *Anjana* (copper-colored pustules in the conjunctiva?)—small, soft, copper-colored pustules occurring on the eyelid and attended with a burning and pricking sensation and a little pain.

8. *Bahala-vartma* (phlegmonous conjunctivitis)—vegetations of pustules (*pidakā*) of equal size appearing all along the eyelid and resembling it in color.

9. *Vartma-bandha* (acute conjunctivitis)—swelling of the eyelid attended with an itching sensation and a slight pain, so as to interfere with the eyelids being uniformly opened.

10. *Klisto-vartma* (angioneurotic edema of the eyelids?)—a mild copper-colored inflammatory swelling of both eyelids simultaneously, attended with a slight pain and suddenly discharging blood.

11. *Kardama-vartma* (blepharitis squamosa)—*Klisto-vartma* in which a biliary disturbance has deranged and affected the blood, with discharge of much dirty matter.

12. *Syāva-vartma* (blepharitis ulcerosa)—a dark brown discoloration of the eyelids marked internally and externally by swelling and attended with a discharge of pus, with burning and an itching sensation.

13. *Braklinna-vartma* (acute gangrenous blepharitis)—an external swelling of the eyelid with an accumulation of mucous matter in its inner surface, accompanied with a slight pain as well as discharge, itching and a pricking sensation.

14. *Parikliṇṇa-vartma* (xerosis conjunctivae)—a sticking together of the eyelids, even in the absence of any suppuration and in spite of constant lavage of the eyes.

15. *Vāta-hata-vartma* (paralysis of the eyelids or ptosis)—drooping (paralysis) of the eyelids, with or without pain, so as to impede the opening of the eyelids, which seem to be out of joint.

16. *Arvūda* (tumor of the eyelid)—a red, knotty swelling of uneven size or shape, attended with a little pain.

17. *Nimeśa* (blepharospasm)—constant spasms of the eyelids due to incarceration of the deranged *vāyu* (nervous force) within the nerves controlling the eyelids.

18. *Śonitarśa* (blood molluscums)—soft and fleshy growths (*ankura*) on the eyelid, attended with pain, itching and a burning sensation, due to a vitiated condition of the blood. These growths reappear after being removed with a knife.

19. *Lagana* (papillary conjunctivitis)—a thick, slimy, hard, painless nodular swelling on the eyelid, resembling a *kola* fruit (*Zizyphus jujuba*) in size and marked by an itching sensation and absence of suppuration.

20. *Viśa-vartma* (eczematous conjunctivitis)—an inflammatory swelling of the eyelid dotted with minute punctures, like the pores in the stem of a water-soaked lotus.

21. *Pakśma-kopa* (trichiasis)—an accumulation of deranged intraocular humor about the eyelashes, making them rough and sharp pointed and giving rise to pain in the eyes. Relief is obtained when the lashes are epilated. The eye affected with this disease cannot bear the least wind or heat or glare of the sun.

The definitions of the eleven diseases of the *śukla-maṇḍala*<sup>35</sup> (sclerotic region) are presented.

35. Suśruta Samhitā,<sup>1</sup> Uttara Tantra, chap. 4.

Definitions and symptoms of the seventeen diseases of the eye as a whole are also given.<sup>37</sup>

The four types of *abhiśyanda* (ophthalmia) are characterized by the following symptoms :

1. *Vāyu-originated abhiśyanda* (of neural origin)—numbness, pricking pain, horripilation, roughness and dryness of the eye, cold lacrimation and headache.

2. *Pittaja abhiśyanda* (due to metabolic or biliary derangement)—burning and inflammation of the bulbar and the palpebral conjunctiva, a longing for cold applications on the eyes, excessive hot lacrimation, cloudy vision and a yellowness of the eyes.

3. *Kaphaja abhiśyanda* (due to derangement of lymph)—a longing for hot applications on the eye, attended with a feeling of heaviness, an itching sensation, swelling, excessive whiteness and a constant deposit of slimy mucus.

4. *Raktaja abhiśyanda* (due to a disturbance of the blood)—redness of the eyes, a flow of copper-colored tears, as in the type of ophthalmia due to biliary derangement, and the presence of deep red vascularization all around (ciliary injection).

The four types of *adhimantha* (uveitis) may originate as follows: The four forms of chronic *abhiśyanda* (ophthalmia), if not properly attended to at the onset, may progress to *adhimantha* (uveitis), which is attended with excruciating pain in the eye, which feels as if it were being torn out and as if the pain were extending upward to and crushing, as it were, half of the region of the head. The characteristic symptoms of the *doshas* (humors) involved in each case predominate.

Suśruta described the specific symptoms of the four types of uveitis as follows :

1. *Vātaja adhimantha* (due to derangement or disease of the nervous system)—cloudiness of the eye; a sensation of the eye being torn out and churned, as it were, with an *arani* (fire-producing wood) ; irritating, piercing and cutting pain ; drying of the local flesh (atrophy) and a twisting and crackling sensation in the half of the head on the side of the affected eye, attended by local swelling, shivering and pain.

2. *Pittaja adhimantha* (due to biliary metabolic derangement or constitutional disease)—a blood-streaked eye, attended with exudation and a sensation therein of being burnt with fire ; chemosis, perspiration and suppuration of the affected organ ; yellowish vision ; fainting fits, and a burning sensation in the head. The eyes become liver-colored and seem as if ulcerated or rubbed with an alkali.

3. *Kaphaja adhimantha* (due to lymphatic derangement)—swelling of the eye, with slight congestion ; a discharge accompanied with a sensation of itching ; coldness and heaviness in the affected localities and horripilation ; sliminess of the eye due to deposits of mucus ; cloudiness of vision ; dilatation of the nostrils ; headaches and visualization of all objects as full of dust.

4. *Raktaja adhimantha* (due to diseases of the blood)—pricking pain in the eye with a blood-streaked exudation, bright red like a *bandhujiva* flower (Pentapetes

37. Suśruta Samhitā,<sup>1</sup> Uttara Tantra, chap. 6.

phoenicia) ; unendurable pain to the least touch or contact ; visualization of objects as if enveloped in flames ; redness of the extremities of the eye, and a likeness of the whole of the *kṛṣṇa-maṇḍala* (black portion of the eye) to an *arīṣṭa* fruit (*Melia azadirachta*) submerged in blood.

The prognosis of the four types of uveitis follows: A course of injudicious and intemperate diet, conduct or medical treatment may usher in blindness within seven days from the onset of the *kaphaja* type of uveitis ; within five days from the onset of the *raktaja* type ; within six days from the onset of the *vātaja* type, and within three days from the onset of the *pittaja* type.

Two types of *akṣīpāka* (suppuration of the globe) are: (1) *saśopha-akṣīpāka* (with swelling) and (2) *aśopha-akṣīpāka* (without swelling).

The symptoms of each type follow :

*Saśopha-akṣīpāka*—itching sensation ; deposit of mucus in the eye ; lacrimation and redness (ciliary injection) of the eye, like the color of a ripe *udumbara* fruit (*Ficus glomerata*) ; a burning sensation in the eyeball, which becomes copper colored and heavy ; a pricking pain and horripilation ; swelling of the eye ; constant secretion of either cold or hot slimy discharges and ultimate suppuration.

All these symptoms except swelling characterize the *aśopha-akṣīpāka*.

The definitions of other diseases of the eye as a whole follow :

*Haṭādhimānṭha* (atrophy of the optic nerve)—incarceration of the deranged *vāyu* (nervous force) in the optic nerve, with impairment of vision. The disease is incurable.

*Vāta-ṭṣyāya* (neuroparalysis of the eyelid ; a disease of neural origin?)—a shifting pain experienced sometimes in the region of the eyelashes or of the eyebrows and sometimes in the region of the eye, due to the coursing of deranged and incarcerated *vāyu* (nervous force) in these localities.

*Śuśkākṣīpāka* (phthisis bulbi ; plastic endophthalmitis)—dryness and hardness of the atrophy of the globe ; constant closure of the eyelids, and cloudiness and haziness of vision.

*Anyato-vāta* (an ocular disease of neural origin)—excessive pain in the eyes or in the eyebrows due to the action of deranged nervous force (*vāyu*) incarcerated in the region of the head, ears and the cheek bones, the back of the neck or in any other adjacent place.

*Amladhysūta* (iritis)—inflammation with chemosis of the iris as well as other adjacent ocular structures, attended with a bluish red tint (ciliary and conjunctival injection), the result of partaking of meals composed of an unduly large proportion of acid foodstuffs or of food that causes an acid reaction in the stomach.

*Śīrot-pāta* (pannus)—copper-colored blood vessels all over the eye, with or without pain.

*Śīrā-harṣa* (higher grade pannus)—a transparent and copper-colored discharge in copious quantity from the eye due to deep-seated vascularization of cornea, with the production of complete blindness. This condition results if *śīrot-pāta* is not attended to and remedied in time.

In chapter 7 of the Uttara Tantra Suśruta described the diseases of the visual apparatus, lens, retina and vitreous.

His descriptions included those of retinitis (*timira*) and cataract (*śleishmika lingaṇāśa*). It is interesting to see how true to nature is Suśruta's description of the macroscopic anatomic structure of the lens, for he stated that the lens simulates a *maśur* pulse (*lenteil*; lens esculenta) in shape and size.

Suśruta also described the following ocular diseases: (1) *pitta-vidagdhadrusti* (day blindness), (2) *kapha-vidagdhadrusti* (night blindness), (3) *dhuma-darśin* (amblyopia; smoky vision), (4) *hrasva-jādyā* (retrobulbar neuritis), (5) *nakulāndhya* (disease of the vitreous; muscae volitantes), (6) *gambhirikā* (glaucoma) and (7-8) two diseases of traumatic origin.

#### CLASSIFICATION OF DISEASES ACCORDING TO SURGICAL TREATMENT

Suśruta classified ocular diseases according to the different modes of surgical treatment.<sup>38</sup> Of the seventy-six varieties of ocular disease, he stated that eleven should be treated with excision (*chhedya*), namely: (1) *arso-vartma* (trachoma), (2) *suskarśas* (granular conjunctivitis), (3) *arvuda* (polypus; tumor of the eyelid), (4) *śirāja-pidakā* (phlyctenule covered with vascularization), (5) *śirā-jāla* (vascularization of the sclera), (6-10) five types of *arman* (pterygium) and (11) *parvanikā* (phlyctenule).

The nine varieties of ocular disease to be treated with scarification (*lekhana*) are: (1) *utsangini* (hordeolum or sty), (2) *bahala-vartma* (phlegmonous conjunctivitis), (3) *klisto-vartma* (angioneurotic edema of the eyelid), (4) *syāva-vartma* (blepharitis ulcerosa), (5) *kardama-vartma* (blepharitis squamosa), (6) *vaddha-vartma* or *vartma-bandha* (acute conjunctivitis), (7) *pōthaki* (follicular conjunctivitis), (8) *kumbhakini* (chalazion) and (9) *vartma-śarkarā* (ulcerative pustular conjunctivitis).

Five varieties of ocular disease should be treated with incision (*bhedya*), namely: (1) *upanāha* (a cystic growth near the limbus), (2) *lagana* (a hard papillary form of conjunctivitis), (3) *visa-vartma* (conjunctivitis eczematosa), (4) *krimi-granthi* (parasitic cyst; myiasis) and (5) *anjana* (copper colored pustules on the conjunctiva).

Names of fifteen varieties of ocular diseases to be treated with venesection (*vyadhana*) follow: (1) *śirōt-pāta* (pannus), (2) *śira-harśa* (higher grade pannus), (3) *saśopha-akśipāka* (sympathetic ophthalmia with swelling), (4) *aśopha-akśipāka* (plastic endophthalmitis),

38. Suśruta Samhitā,<sup>1</sup> Uttara Tantra, chap. 8.

(5) *anayto-vāta* (disease of neural origin), (6) *puyālasa* (acute dacrocystitis), (7) *vāta-paryāya* (disease of neural origin; see definition), (8-11) four types of *abhiśyanda* (ophthalmia) and (11-15) four types of *adhimantha* (uveitis).

The names of twelve inoperable diseases of the eye follow: (1) *śushkākshipāka* (phthisis bulbi), (2) *pitta-vidagdhdrusti* (day blindness), (3) *kapha-vidagdhdrusti* (night blindness), (4) *amladhyuśita* (iritis), (5) *śukra-roga* (corneal ulcer), (6) *arjuna* (a blood red raised speck on the sclera), (7) *pištaka* (a grayish looking fleshy spot on the sclera), (8) *pariklinna-vartma* (xerosis conjunctivae), (9) *dharma-darśin* (amblyopia; smoky vision), (10) *śuktikā* (pinguecula), (11) *praklinna-vartma* (acute gangrenous conjunctivitis), (12) *balāsa* (a shining grayish white speck on the sclera covered by vessels).

Suśruta did not consider surgical treatment advisable for the two types of traumatic ophthalmia but indicated for *śleishmika lingaṇāsa* (cataract) and *pakśma-kopa* (trichiasis).

Names of sixteen ocular diseases, either incurable or difficult of cure, are given by Suśruta as follows: (1) *hatādhimantha* (atrophy of the optic nerve), (2) *nimeśa* (blepharospasm), (3) *gambhirikā* (glaucoma), (4) *vāta-hata-vartma* (paralysis of the eyelids), (5) *jala-srāva* (lacrimal fistula), (6) *ajakā-jāta* (sarcoma of the eye), (7) *śonitārśa* (blood tumors of molluscums), (8) *hrasva-jādyā* (retrobulbar neuritis), (9) *savvana-śukra* (ulcerative keratitis), (10) *nakulāndhya* (disease of the vitreous), (11) *puya-srāva* (lacrimal sinus), (12) *akṣipākātyaya* (hypopyon), (13) *alaji* (larger phlyctenule near the limbus) and (14-15) septic traumatic ophthalmia.

#### OPERATIVE TECHNIQS

Having considered the anatomic structure and the diseases of the eye as described by Suśruta and the masterly manner in which he has analyzed these various diseases as operable and inoperable, I shall describe the various ophthalmic operations as performed by him in the prehistoric, preanesthetic and preophthalmoscopic age.

The technic of Suśruta's surgical treatment for *arman* (pterygium) by excision (*chhedana*) is considered first. As stated before, Suśruta mentioned five different varieties of *arman*.<sup>39</sup>

The patient should be treated with a mild purgative the day before operation and should be given a mild and nonstimulating diet. For the operation, he should be made to lie at ease, and the affected part of the eye should be irritated by sprinkling powdered *saindhava* salt (sodium chloride) into the socket of the eye in order to loosen the *arman*. The

39. Suśruta Samhitā,<sup>1</sup> chap. 15.



irritated *arman* should be thoroughly fomented with *karasveda* (fomentation with the palm which is heated by rubbing it with the finger). The surgeon should then ask the patient to look toward the *apāṅga* (exterior corner) of the affected eye. At this time the *arman* should be secured carefully at its loosened and upturned part with the *vadiśa*

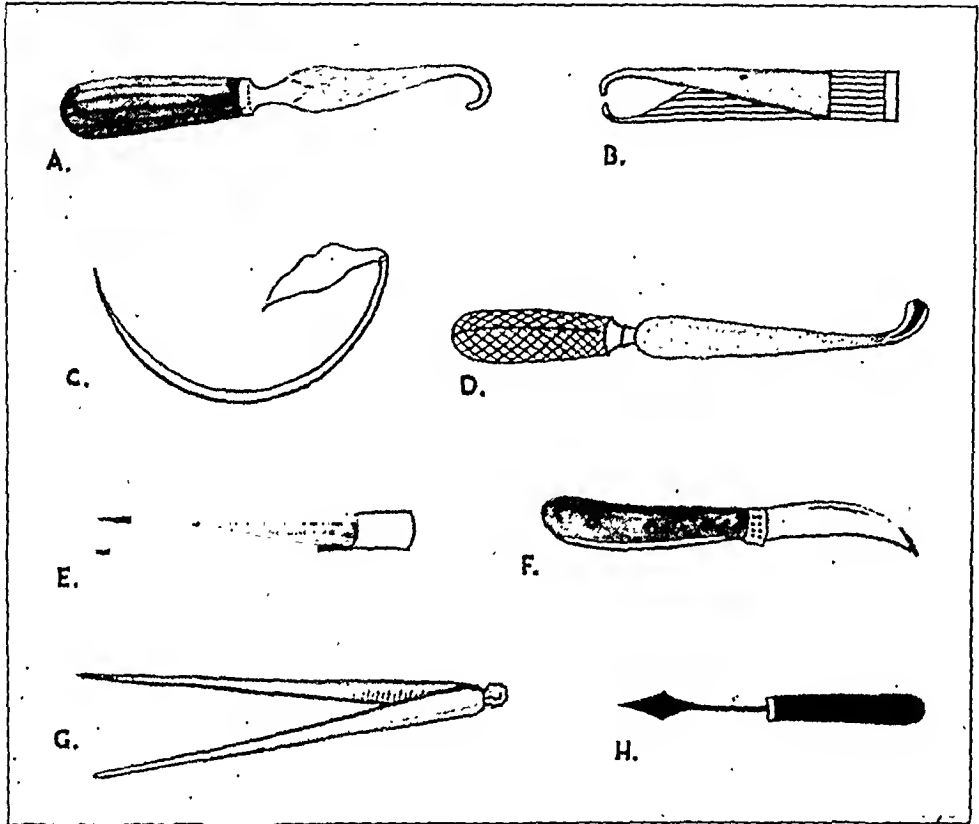


Fig. 1.—Suśruta's instruments. *A*, *vadiśa jantra* (sharp hook). This instrument is 6 *anguli* (fingers) in length; its hook is  $\frac{1}{2}$  *anguli* in length and its handle  $5\frac{1}{2}$  *angulis*. The end of the hook is sharply edged and is bent. (From Mukherjee; <sup>40b</sup> Suśruta Samhitā.<sup>40a</sup>) *B*, *muchundi jantra* (toothed forceps). This instrument consists of a pair of straight forceps used for holding the pterygium. (From Mukherjee; <sup>41c</sup> Vāgbhatta; <sup>41a</sup> Suśruta Samhitā.<sup>41b</sup>) *C*, *su-sutra suchi* (a well threaded needle). (From Mukherjee; <sup>42a</sup> Vāgbhatta; <sup>41a</sup> Suśruta Samhitā.<sup>42c</sup>) *D*, *mandalāgra śastra* (a sharp round-topped cutting instrument). (From Mukherjee,<sup>15</sup> chap. 6, p. 225 and 226; Suśruta Samhitā.<sup>40a</sup>) *E*, *samdanśa* (forceps for catching tissue). (From Vagbhatta; <sup>41a</sup> Suśruta Samhitā,<sup>41b</sup> p. 147. *F*, *vrddhipatra śastra* (cutting knife or scalpel). This is made up of steel. The handle and blade should measure  $5\frac{1}{2}$  and  $1\frac{1}{2}$  *angulis* (fingers), respectively. (From Mukherjee; <sup>40b</sup> Suśruta Samhitā, p. 36). *G*, *pakśma-kopa samdanśa* (epilation forceps). (From Mukherjee,<sup>15</sup> p. 104.) *H*, *vrihimukha śastra* (a sharp cutting or incising knife). It is made of steel, and the sharp end is pointed and shaped like a grain of paddy. It is 6 *angulis* (fingers) in length, the handle being 2 *angulis* in length and the blade 4 *angulis*. (From Mukherjee,<sup>15</sup> p. 257; Vagbhatta; <sup>41a</sup> Suśruta Samhitā,<sup>1</sup> Sūtrasthāna, p. 155.)

*jantra* <sup>40</sup> (sharp hook, fig. 1 *A*), and held up with a *muchundi jantra* <sup>41</sup> (toothed forceps, fig. 1 *B*), or a threaded needle <sup>42</sup> (*su-sutra Suchi*, fig. 1 *C*) should be passed from below the part, which will be held up with the thread. It is dangerous to lift the *arman* suddenly by stretching, as it will rupture. The two eyelids should be drawn apart so as to guard against their being injured during the maneuver. Then the *arman*, thus held up, should be removed, by scratching it with a sharp *mandalāgra śastra* <sup>43</sup> (a sharp, round-topped instrument, fig. 1 *D*). The root of the *arman* should be pushed away from the black outline of the eye to the extremity of the *kaninikā* (the mesial angle of the eye) and then excised and removed, thus freeing the eye from the fibrovascular growth. The *kaninikā* (the mesial angle of the eye) should be duly guarded from injury. If a quarter of the *arman* is left intact by chance, it does not harm the eye. If during the operation the *kaninikā* is cut, hemorrhage and later lacrimal fistulas will result. If less than half the *arman* is excised or if it is cut insufficiently, the *arman* will soon recur.

An *arman* which has expanded like a fishing net and which is situated on the sclera near the inner canthus should be irritated and loosened by rubbing it with *saindhava salt* <sup>44</sup> (sodium chloride); it should then be held up by the *vadiśa jantra* (sharp hook) and carefully excised with the *mandalāgra*. The site of the excision should be rubbed with a compound consisting of *yavakshāra* (potassium carbonate), *trikatu* (Piper longum, dry ginger and black pepper) and *saindhava salt* (sodium chloride) pounded together, then fomented with *yavakshāra* and bandaged by the surgeon. Oily medicament (*sneha*) should be prescribed with due regard to the nature of the place, season and time and the vitality of the patient. The incidental wound should be treated as an ulcer. The bandage should be removed after three days, and the affected part should be mildly fomented with *karasveda* and treated with ulcer-healing remedies.

In the event of pain in the eye, an *āśchyotana* (eye lotion) made of *karanja* seeds (*Gongamia glabra*), *amalaka* (*Embelia officinalis*) and *yastimadhu* (*glycyrrhiza*) soaked with milk and mixed with honey (when cold) should be used twice a day. A cold application composed of *yastimadhu* (*glycyrrhiza*), pollens of lotus (*Utpala keśara*) and *durba* grass (*Eragrostis cynosuroides*) and made into a paste with milk

40. (a) *Suśruta Samhitā*,<sup>1</sup> *Sūtrasthāna*, chap. 7, p. 33. (b) Mukherjee,<sup>15</sup> p. 264.

41. (a) Vagbhatta: *Astangahridayasamhitā*, edited by Anna Moreswar Kunte, Bombay, Nirnaya Sagara Press, 1912; (b) *Suśruta Samhitā*,<sup>1</sup> *Sūtrasthāna*, chap. 25, p. 148. (c) Mukherjee,<sup>15</sup> pp. 105-106.

42. (a) Mukherjee,<sup>15</sup> p. 243. (b) Vagbhatta.<sup>41a</sup> (c) *Suśruta Samhitā*,<sup>1</sup> *Sūtrasthāna*, chap. 26, p. 146.

43. *Suśruta Samhitā*,<sup>1</sup> *Sūtrasthāna*, chap. 8, p. 35.

44. Sen Gupta Kavinaaj: *Materia Medica of the Hindus*, ed. 9, 1934, p. 99.

and clarified butter should be applied to the forehead in such cases. If there is any remnant of the *arman* after excision, it should be removed with a scarifying ointment (*lekhyā anjana*).

The variety of *arman* which is small and white like curd or bluish red or gray should be treated like a corneal ulcer (*śukra*).

The variety of *arman* which has become sclerosed, thickened, fleshy and vascular and which has encroached on the cornea should be excised.

When an *arman* is properly excised, the eye assumes its former and natural color, and its functional capacity remains unimpaired; the eye is free from pain and other complications.

The other ocular diseases for which Suśruta advocated excision follow with a description of the technic and treatment:

In *śirā-jāla*, in which the vessels become hardened and sclerosed, the vessels should be secured with the *vadiśa jantra* and excised with the *mandalāgra*.

In *śirāja-pidakā*, in which there are phlyctenules interlaced with vessels, a condition not amenable to medical treatment, the vessels should be excised, as in a case of an *arman*, with the *mandalāgra*. *Pratisārana* (rubbing), as in a case of an *arman* (pterygium), and *lekhana* (scraping), with due regard to the nature of the deranged humors involved in each case, are also recommended in both the diseases.

In *parvanikā* (copper-colored papule or phlyctenule at the limbus), the junction of the sclera and the cornea should be only fomented; the upper third of the papule should be held secure by the *vadiśa jantra* and excised with a *mandalāgra*. The site of the operation should be rubbed (*pratisārana*) with a compound of honey and *saindhava* salt (sodium chloride). If any remnant of the disease remains, *lekhana churna* (scarifying powder) should be applied. *Lekhana churna* consists of the powders of *śamkha* (conch shell), *samudraphena* (*Sepia officinalis*), marine oyster-shell, crystal, ruby, coral, *aśmantaka* (jewel), *vaidurya* (Lapis lazuli), pearl, iron, copper and *srotanjana* (antimony) taken in equal parts and mixed together. It should be stocked in a ram's horn and applied to the affected portion every morning and evening. Such applications are highly efficacious in all types of *arman* (pterygium) *śirāja-pidakā*, *śirā-jāla*, polyps and disturbance of humors.

Suśruta next dealt with the surgical treatment of ocular diseases affecting the inner surface of the eyelids.

After fomentation of the eyelid, the lid should be everted with a *samdanśa* (forceps for catching tissue, fig. 1 E) and the growth carefully lifted up with a needle. It is then cut at its root or base with a sharp *mandalāgra*. Afterward the part should be rubbed with a pulverized compound consisting of *saindhava* salt (sodium chloride), *kasisa* (ferrous sulfate) and *pippali* (long pepper). After the bleeding has ceased, the affected part of the eyelid should be carefully cauterized

with a red hot *śalākā* (metallic probe). If there is any remnant of the disease, scarification should be done with a caustic alkaline preparation. A decoction of strong emetics and purgatives should be administered for the elimination of the bodily toxins and the pacification of deranged bodily humors. The measures and remedies used in the treatment of *abhiśyanda* (ophthalmia) should also be prescribed. After the surgical operation, the patient should observe a strict regimen of diet and conduct for a month, during which time the eye should be kept well protected with a bandage.

For *pakśma-kopa* (trichiasis), Suśruta<sup>45</sup> advocated the following modes of treatment: (1) operation; (2) cauterization with fire; (3) cauterization with alkali, and (4) application of medicinal drugs. Of the four forms of treatment, that of operation is described first:

The patient should first be treated with an oleaginous medicament (*sneha*) for cleansing his bowels and pacifying the deranged humors and bodily toxins. For the operation, he should be laid in a comfortable and suitable position. An area lying two parts below the eyebrow and one part above the eyelashes and uniformly (elliptically) parallel to the part of the eyeball lying between the *kaninikā* (the mesial angle) and the *apāṅga* (the exterior corner) should be marked out on the eyelid. Incisions about the dimension of a barley corn should be made in this area with a *vrddhipatra śāstra*<sup>46</sup> (cutting knife) or scalpel (fig. 1 F). The area should then be dissected with the knife without injury to the underlying structures. The two edges of the incision should be sutured with horsehair. Honey and clarified butter should be applied to the operated part. The wound should then be treated as an incidental ulcer. A piece of linen should be tied round the forehead, and horsehair suture should be attached thereto (fig. 2). The horsehair sutures should be carefully removed after the complete adhesion of the two edges of the wound.

In case of failure with these measures, the eye should be lifted in an inverted position and the diseased area should be carefully cauterized with fire or alkali. Again, in case there is no relief with these modes of treatment the *pakśma-māla* (eyelashes) should be secured with three hooks (*vadiśa jantra*) and removed at one operation with an epilation forceps<sup>47</sup> (*pakśma-kopa samdanśa*, fig. 1 G). The affected part should then be rubbed with a paste of *haritaki* (*terminalia chebula*) and *tuvaraka* (*symblocos racemosa*).

45. Suśruta Samhitā,<sup>1</sup> Uttara Tantra, chap. 16.

46. (a) Suśruta Samhitā,<sup>1</sup> Sūtrasthāna, chap. 8. (b) Mukherjee,<sup>15</sup> p. 233.

47. Mukherjee,<sup>15</sup> p. 105, fig. XVI.

The four aforesaid measures are capable of curing trichiasis, but the cure may be temporary, as the disease is a *yāpya* one (admitting only of palliative treatment).

Purgatives, an eye lotion (*aśchyotana*), medicinal snuffs (*nasya*), fumigations, inhalations, plasters and collyria should likewise be held as beneficial for *pakśma-kopa*.

For scarification (*lekhana*) Suśruta<sup>48</sup> stated that the patient should be seated in a room which is not exposed to the rays of the sun and the blasts of the wind, after having been treated with proper emulsive measures and subjected to a course of emetics and purgatives.

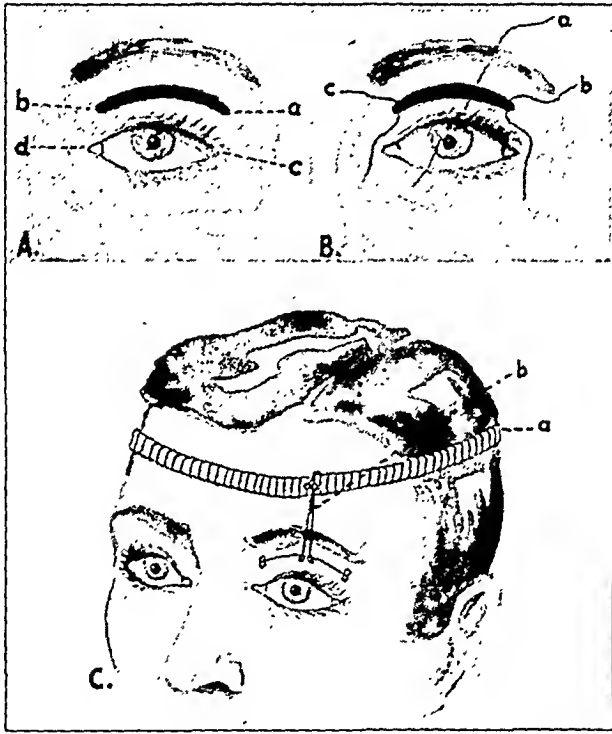


Fig. 2.—*A*, the first stage of Suśruta's operation for *pakśma-kopa* (*trichiasis*). The incision (*a* and *b*) is two parts below the eyebrow and one part above the eyelashes and should be of the dimension of a barley corn. The direction of the incisions should be elliptically parallel to a line drawn from the *kaninikā* (*d*, mesial angle) and the *apāṅga* (*c*, the exterior angle). *B*, the second stage of the operation. The elliptic piece of skin lying between the incisions has been dissected out, and the edges of the incision are sutured with horsehair (*a*, *b* and *c*). *C*, the third stage of the operation. The incised edges have been stitched with horsehair. A piece of linen (*a*) is tied round the forehead of the patient. The horsehair suture (*b*) is attached to the piece of linen.

The patient's eyelid should be everted with the thumb and index finger and should be cautiously fomented with a piece of linen which has been soaked in lukewarm water and then squeezed. The eyelid

48. Suśruta Samhitā,<sup>1</sup> Uttara Tantra, chap. 13.

should be everted with the lint-covered index finger and thumb in such a way that the lid does not tremble or droop down. It should be kept steady. Then the eyelid should be rubbed with a piece of linen and scribbled and scarified with a *lekhaṇa śāstra*<sup>49</sup> (a scarifying knife, *vrihimukha śāstra*, fig. 1 H) or with a *śephalikā* leaf (*nyctanthes arbor-tristis*). After cessation of bleeding, the part should be thoroughly fomented and gently rubbed with a medicinal compound consisting of *manahśilā* (realgar), *kaśisa* (ferrous sulfate), *trikatu* (red pepper, ginger and black pepper), *anjana* (black antimony), *saindhava* salt (sodium chloride) and *swarna-makśikā* (copper pyrites) finely pounded together. Thereafter the part should be bathed with lukewarm water and lubricated with clarified butter. The after-treatment is like that for ulcer. After three days, fomentations should be prescribed.

Indications of a properly scribbled eyelid are: freedom of the lid from bleeding, freedom from swelling and itching and a smooth surface resembling the color of the surface of the nail.

Symptoms of badly or injudiciously scarified eyelid are: profuse bleeding from the scarified area, an injected eye, chemosis, discharge, dimness of vision, brownishness, heaviness, numbness, itching sensation, horripilation and sticking of the eyelids. If the eye is not properly and promptly treated, a severe type of *netra-pāka* (panophthalmitis) will ensue. The badly scarified eyelid should again be anointed with oily application and rescribbled properly.

Symptoms of overscarification consist of: eversion of the lid, spontaneous uprooting of the eyelashes, pain in the lid and an excessive inflammatory discharge. Fomentation, application of oily medicaments and antiphlogistics should be employed in such cases.

In cases of *vartma-bandha* (acute conjunctivitis), *klisto-vartma* (angioneurotic edema of the lid); *bahala-vartma* (phlegmonous conjunctivitis) and *pothaki* (follicular conjunctivitis) the eyelid should first be gently and slowly scraped and then scarified with the *vrihimukha śāstra*.

In cases of *syāva-vartma* (blepharitis ulcerosa) and *kardama-vartma* (blepharitis squamosa) the scarifying should be uniformly done throughout the area, neither deeply nor superficially. In cases of *kumbhakini* (chalazion), *vartmaśarkarā* (ulcerative pustular conjunctivitis) and *utsangini* (hordeolum) the affected parts should be cut with the *vrddhipatra śāstra* and then carefully scarified and scribbled with the *vrihimukha śāstra*.

Copper-colored *pidakās* (papules and pustules) occurring in the eyelids should first be incised with the *vrddhipatra śāstra* after suppuration and then scarified with the same instrument. Small and slightly

49. Vagbhata.<sup>41a</sup> *Suśruta Samhitā*,<sup>1</sup> *Sūtrasthāna*, chap. 26, p. 154.

raised swellings and papules occurring on the exterior surface of the eyelid which are recent and not accompanied by inflammation should be treated with fomentation, plasters and corrective measures without recourse to scribbling and scarifying.

Suśruta's technic for the surgical treatment of ocular diseases by incision (*bhedana*)<sup>50</sup> is considered next.

For the treatment of *visa-granthi* (eczematous conjunctivitis of the suppurative type *visa-vartma*), the eyelid should first be fomented; then its puncture-like pores should be completely incised with a *vrihimukha śāstra*. The lid should be dusted over with *saindhava* salt (sodium chloride), *kasisa* (ferrous sulfate), *māgadhi* (Piper longum), *manahśilā* (realgar) and *elā* (large cardamom seeds) pounded together. Honey and clarified butter should then be applied over the dusted part and a loose bandage employed for complete union of the parts.

For the treatment of *lagana* (papillar conjunctivitis), an incision should be made into the nodules or papules of the affected part and any of the following agents—*rōchana* (Mallotus philippinensis), *yavakshāra* (potassium bicarbonate), *tuttha* (cupric sulfate), *pippali* (Piper longum) or honey—should be applied to the incised part, while in cases of serious involvement cauterization with alkali or with fire should be the remedy.

For the treatment of *anjana* (copper-colored pustules in the conjunctiva), the affected part of the eyelid should be duly fomented, and if a pustule ruptures spontaneously a compound of *manahśilā* (realgar), *elā* (large cardamom seeds), *saindhava* salt (sodium chloride) and *tagarapādukā* (Valeriana hardwicitrii) mixed with honey should be pressed on it. If, however, the surgeon wants to open a pustule, it should be rubbed with a mixture of honey and *rasānjana* (extract of berberis asiatica) and then coated with warm collyrium made from lamp black collected from a burning lamp flame.

The surgical treatment of *krimi-granthi* (parasitic cyst; myiasis) consists of incision with a *vrihimukha śāstra*. The affected part should then be fomented and treated with a chemical solution prepared by the decoction of *triphala* (Terminalia chebula, Terminalia belirica and Embilica officinalis) with the addition of *tuttha* (cupric sulfate), *kāsisa* (ferrous sulfate) and *saindhava* salt (sodium chloride).

In a case of *upanāha* (cystic growth near the limbus), which is due to the action of deranged intraocular lymph, the affected part should be opened with a *vrddhipatra śāstra* and rubbed with *pippali* (Piper longum) and *saindhava* salt (sodium chloride) mixed with honey. It should then be scraped with a *mandalāgra*. The surrounding area should also be gently scratched all round with a *vrihimukha śāstra*.

50. Suśruta Samhitā,<sup>1</sup> Uttara Tantra, chap. 14.

For the foregoing five types of *bhedya* (incisable) ocular diseases, until suppuration has commenced the affected part should first be treated with an oily medicament and then with light fomentations with the aid of tender leaves as a cover for the eye. As a routine preliminary treatment in all cases in which an incision is to be done, the patient should be duly cleansed and purified with emetics and purgatives.

In chapter 27 of the Uttara Tantra, verses 55 to 100, Suśrūta dealt with the causation of varieties of cataract and described the technic of lens couching. He advocated the treatment of mature cataractous lens (*śleishmika lingaṇāśa*). He described the preoperative treatment and the operative technic, discussed the routine postoperative treatment and concluded by giving the contraindications for couching.

Lens couching should be done in a season which is neither very hot nor very cold. On the day before operation the patient should be purged by means of emulsive measures and purgatives and should be given a nonstimulating diet. On the day of the operation he should possess a cool temper and an unperturbed and cheerful mind. He should be seated on a specially constructed and designed operating table and should look uniformly toward his nose and should not move the eye in any direction.

The surgeon should open the eye carefully and sufficiently, and an assistant should keep the lids stretched apart. The point of puncture should be just outside the junction of the black and white regions (limbus) on the temporal side and should be in a line dividing the white portion (sclera) equally into two segments, upper and lower, and should not be over the plexus of blood vessels. It should be in the line of the natural aperture (*daiba-kṛita-chhidra*). The surgeon should hold the *jaba-mahiki śālākā* (the curved barely-mouthed needle) in the middle carefully, steadily and confidently with the thumb, the forefinger and the middle finger and should puncture through the natural aperture, neither above nor below nor laterally, using the right hand for the left eye and the left hand for the right eye. A correct puncture will be indicated by exudation of a drop of water and a sound; an incorrect puncture will be followed by bleeding.

Immediately after the puncture, the eye should be sprinkled with breast milk. Then with the *śālākā* fixed, light fomentation should be applied externally to the eye. After the cataract is reached through the natural aperture, it should be scribbled and scarified with the tip of the *śālākā* till it is dislodged out of the visual field. The patient's nose will be closed in the meantime, and he should be asked to sniff, sneeze and suck in the phlegm from the nasal sinuses into his throat. The proper dislodgment of the cataractous lens will be heralded by the clearing of vision, as the sun becomes brilliant after the clearance of



clouds, and the eye will be painless. Then the barely-mouthed *śalākā* should be carefully and gently withdrawn. Lukewarm clarified butter should be poured into the eye; lint soaked in the same should be put over it, and the eye should be bandaged properly.

After the operation the patient should lie flat in a room that is free from dust and smoke, protected from sun's rays and well ventilated and should remain calm and quiet. He should not eructate, yawn, cough, sneeze or spit. The eye should be opened on the third day, washed with a warm decoction of drugs of soothing, antiphlogistic and antiseptic properties (decoction of root of *Ricinus communis* and myrobalan) and bandaged again with a fresh bandage. Compresses should be applied on the fourth day. The eye should be regularly treated every third day with compresses and lavage, and a fresh bandage should be applied. The patient should take only liquid food and a sufficient quantity of fresh milk daily for ten days, after which his food should consist of light solid food in moderate quantities. If all goes well, the bandages may be removed on the tenth day, and the patient should be restrained from looking at dazzling light and the glaring sun till the eye is restored to its normal condition.

Suśruta gave the contraindications for the operation in verse 37, chapter 17, and also described the symptoms, the treatment of the disorders and the complications resulting from an injudicious or faulty operation in verses 37 and 38.

#### COMMENT

A critical and unbiased review of Suśruta's ophthalmic works will show that his terminology of ocular diseases is no less exhaustive and elaborate than that of the modern ophthalmologist. He classified the various ocular diseases on an anatomic basis in a most scientific and original manner. In chapter 8 he ingeniously classified them according to the different modes of surgical (operative) treatment, which distinctly shows the masterly grasp he had on the subject. Suśruta's observations were so keen and meticulous that such diseases as *krimi-granthi* (parasitic cyst; myiasis) did not escape his clinical and surgical eye. His description and classification of *armans* (pterygium) into five different clinical entities show the masterly way in which he studied and observed the disease, while most modern ophthalmologists, Fuchs<sup>51</sup> for instance, have described four varieties. His operative technic for the surgical treatment of pterygium is as perfect as, or perhaps more perfect and elaborate than, that of any modern ophthalmic operation. His method can well be adopted with benefit even today by the modern ophthalmologist.

51. Fuchs, E.: Diseases of the Eye, ed. 10, translated by E. V. L. Brown, Philadelphia, J. B. Lippincott Company, 1933, p. 144.

In the Suśrutian age there was of course no ophthalmoscope and no microscope. Suśruta, however, not only knew the macroscopic anatomic structure of the eye fully but spoke of the existence of microscopic layers when describing the *patalas* (coats of the eye). In chapter 1 he stated that each of the *patalas* (coats of the eye) has divisions and subdivisions. Also, in describing the progress and prognosis of *avranasūkra* (nonsuppurative keratitis) in chapter 5, he said that if the condition is of long standing but the cornea is mobile and is covered with shreds of highly vascularized conjunctival tissue which stretch down to the second layer and obstruct vision and are marked with a reddish tint (interstitial keratitis), cure should be considered difficult.

Suśruta's knowledge of the development of the eye, which he learned from his teacher Dhanwantari,<sup>30</sup> and also the statement in the Rig-veda<sup>31</sup> that the eyes develop from the cephalic portion of the fetal body are in consonance with modern researches.

Suśruta's views regarding the mode of treatment and prognosis of the various ocular diseases stand as unaltered today as when he taught them. To cite only a few instances, his teaching as to the prognosis of *hatādhimanthā*<sup>38</sup> (atrophy of the optic nerve) and *gambhīrikā*<sup>38</sup> (glaucoma), that is, that they are difficult to cure (*asādhya*), is in consonance with modern teaching. His views as to the prognosis of *adhimanthā*<sup>37</sup> (uveitis) are also in keeping with the views of modern ophthalmic surgeons. Concerning glaucoma, Duke-Elder<sup>52</sup> stated: "In the majority of cases, whether the tension be controlled by myotics or by operative means, although the immediate end may be successfully attained, the disease cannot be considered as cured. Suśruta gave the prognosis for *adhimanthā* (uveitis) as follows: A course of injudicious diet, conduct or medical treatment may usher in blindness within seven days from the onset of the *kaphaja* type of uveitis (due to derangement of intra-ocular lymph); within five days from the onset of the *raktaja* type (due to derangement of the blood), within six days from the onset of the *vataja* type (of neural origin) and within three days from the onset of the *pittaja* type (due to biliary derangement). For comparison with the modern prognosis of uveitis, the following statement of May and Worth<sup>53</sup> is cited: "It [the prognosis] varies with the severity of the symptoms and the general health of the patient, but is always serious. Although in many cases the disease may run a comparatively mild course and the eye may recover with little injury, a severe attack may result in blindness with atrophy of the globe."

Suśruta's surgical treatment of *pakṣma-kopa*<sup>45</sup> (trichiasis) is so elaborate that the modern ophthalmologists may well adopt his method

52. Duke-Elder, S.: *Recent Advances in Ophthalmology*, ed. 3, Philadelphia, P. Blakiston's Son & Co., 1934, chap. 12, p. 402.

53. May and Worth,<sup>25</sup> chap. 11, p. 159.

with advantage. He holds that trichiasis admits of only palliative treatment. His treatment of this disease is fourfold, viz., by (1) operation, (2) cauterization with fire, (3) cauterization with alkali and (4) application of medicinal drugs. His operative technic for the surgical treatment of trichiasis may well be compared with the Jaesche-Arlt<sup>55</sup> operation.

Of course, it may be said that Suśruta does not mention the use of any antiseptics during the operations. Probably the natural lysozymes of the eye as well as the use of different medicaments mixed with mother's milk, honey, clarified butter and sodium chloride and lavage of the eye with antiseptic and antiphlogistic drugs helped him to combat bacterial infection and sepsis.

Suśruta was the world's first surgeon to do the classic cataract operation of lens couching. Clapp,<sup>54</sup> in describing the history of the couching operation, wrote: "Elliott accredits Celsus, a contemporary of Christ, as the earliest author whose description of the operation is available at the present time. Celsus refers to the writings of the great Alexandrian surgeon, Philoxenes, who lived in the third century of the Christian Era." Wilmer,<sup>55</sup> in his foreword to Clapp's text, said: "As early as 300 B.C., the crystalline lens was described by Herophilus." It pains me to see that Suśruta, who was the world's first ophthalmic surgeon to have described the crystalline lens and to have done the classic cataract operation, is not referred to by any of the writers on ophthalmic surgery. Dr. Dutt,<sup>56</sup> in his article "Cataract Operations in the Prehistoric Age," has aptly called Suśruta "the Father of Cataract Surgery." Although ever since the time of Suśruta newer and more complicated procedures are being devised and advocated for the operative technic of cataract, all of them introducing more manipulative difficulties at the time of the operation and most of them more dangerous afterward (to quote from Duke-Elder<sup>57</sup>), the fact remains that Suśruta was the inventor of the cataract operation in the prehistoric age and that he cannot be branded now as a couching operator, since in the preantiseptic Suśrutian age this method probably gave him the best results.

Suśruta's ocular therapy is most exhaustive, and many new medicaments may be added to modern ophthalmic practice. I hope to publish a separate paper on Suśruta's ocular therapy in due course. For the present I wish to reiterate that Suśruta was the first to use mother's milk<sup>27</sup> as a hemostatic, nutritive and soothing agent in ocular therapy

54. Clapp, C. A.: *Cataract: Its Etiology and Treatment*, Philadelphia, Lea & Febiger, 1934, chap. 16, p. 145.

55. Wilmer, W. H.: Foreword to Clapp.<sup>54</sup>

56. Dutt, K. C.: *Cataract Operations in the Prehistoric Age*, Arch. Ophth. 20:1 (July) 1938.

57. Duke-Elder,<sup>52</sup> chap. 11, p. 361.

and also the first to introduce *dāru haridrā*<sup>28</sup> (*Berberis asiatica*) and *raśānjana* (extract of *Berberis asiatica*), cupric sulfate, sodium chloride and other agents into ophthalmic practice.

Suśruta's ophthalmic surgery is written in chaste classical Sanskrit; hence it has become a sealed book to the ophthalmologists who do not know the language. I have given a complete introduction to Suśruta's voluminous ophthalmic surgery. I have long endeavored to study the original Suśruta Samhitā under the patronage and financial help of Maharaja Sri Sudhangsu Sekhar Singh Deo, the enlightened ruler of Sonpur State. Besides the original Samhitā, I have freely consulted the works of the many learned authors who have written on Suśruta. I have also consulted Kavirajes Tarkatirtha and Raigurn for many of my difficult points.

Considering the prehistoric age in which Suśruta lived—the pre-antiseptic, preophthalmoscopic age—one is astounded and surprised on perusal of his ophthalmic works to see the great advancement made in ocular surgery during this time. Great men are assets of no particular nation or country. They belong to the universe, and their achievements are the properties of the whole world. Suśruta, the first great surgeon and ophthalmologist of ancient India and the prehistoric world, has left a legacy in the form of his medicosurgical works for the benefit of the world at large. The history of surgery and of ophthalmology would remain incomplete without Suśruta. Indeed, it would be unfair if one did not acknowledge the debt owed to Suśruta.

In this paper I have tried as far as I could to give medical nomenclature to Suśruta's ocular diseases, with confidence in many cases and diffidence in some.

I conclude my paper by quoting Suśruta's memorable verse<sup>58</sup> at the end of his discourses on ophthalmic operations.

The science of ophthalmic surgery is as vast as the ocean; it is a growing science. One should not think that everything is written in these verses. The underlying principles of the science of ophthalmology, as written in these verses, would therefore sprout, grow and bear good fruits only under the congenial heat of the medical genius.

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58. Suśruta Samhitā,<sup>1</sup> Uttara Tantra, chap. 19, verse 15.

# ADRENAL NEUROBLASTOMA, WITH PARTICULAR REFERENCE TO METASTASIS TO THE ORBIT

REPORT OF A CASE AND NOTES ON TWO OTHER CASES

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Adrenal neuroblastomas are malignant neoplasms arising from the sympathetic neuroblasts in the medulla of the adrenal gland.<sup>1</sup> There are two clinical types, based on the differences in distribution of metastasis, with overlapping of the two in a small percentage of cases. The first type was described by Pepper<sup>2</sup> in 1901. It occurs in the stillborn and in young infants. The neoplasm invades the liver and regional lymph nodes, then the lungs, and late in the course, the calvarium and other flat bones. The second type was described by Robert Hutchinson<sup>3</sup> in 1907. The Hutchinson type is characterized clinically by secondary growth in the orbit, meninges, skull and long bones and occurs in children up to 15 years of age, the largest number occurring in children between the ages of 2 and 3.

A review of some 200 cases reveals no true differences in the two types of tumors since they are undistinguishable pathologically and roentgenographically, merely varying in their distribution in different age groups.<sup>4</sup> Approximately 25 per cent of neuroblastomas metastasize to the orbit and skull, producing the signs and symptoms of the Hutchinson syndrome. Ophthalmologists are concerned only with the Hutchinson type of neuroblastoma. Here the earliest manifestations of the disease are ecchymosis of the lids or exophthalmos or both; the condition is usually unilateral and occurs in children who are from 1 to 15 years of age. Secondary growths soon occur on the outer surface of the skull, especially in the temporal fossae. Hydrocephalus develops rapidly, associated with papilledema and increased proptosis. Debilitation is rapid, associated with a low grade fever, marked anemia and usually slight

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From the Department of Ophthalmology, University Hospital, University of Michigan.

1. Wright, J. H.: Neurocytoma or Neuroblastoma: A Kind of Tumor Not Generally Recognized, *J. Exper. Med.* **12**:556, 1910.

2. Pepper, W. A.: Study of Congenital Sarcoma of the Liver and Suprarenal, *Am. J. M. Sc.* **121**:287, 1901.

3. Hutchinson, R.: Suprarenal Sarcoma in Children with Metastases in the Skull, *Quart. J. Med.* **1**:33, 1907.

4. Bergstrom, V. W.: Congenital Neuroblastoma of the Adrenal, *Am. J. Clin. Path.* **7**:516, 1937.

leukocytosis. No sexual changes are found, as in cases of cortical hypernephroma. The disease is fatal in one to six months from the appearance of the early signs.

Only a provisional diagnosis can be made from these findings, since the primary adrenal tumor is rarely palpable. Pyelograms may reveal a displacement of the kidney downward with a mass above, thus aiding in diagnosis of the primary growth.

Roentgen examination of the skull reveals a fine granular type of osteoporosis produced by multiple metastatic foci with resorption.<sup>5</sup> The growths are subperiosteal and are situated on the inner and outer tables of the skull. In the long bones changes are more likely to be in the ends of the diaphysis adjacent to the epiphysial line. The resorption often is of uneven density, suggesting a diffuse infiltration rather than a massive destruction. Increased intracranial pressure causes widening of the sutures and increased digital markings.

Differential diagnosis may be difficult, but biopsy and roentgen examination aid in differentiating neuroblastoma from lymphoma, myeloblastoma or lymphosarcoma. Studies of the blood will differentiate those dyscrasias which cause ecchymosis and proptosis. While in chloroma there is an involvement of the flat bones of the skull with secondary extension to the orbit, the microscopic picture is typical, the blood shows leukemic changes, and the tumor assumes a green color on exposure. Scurvy may cause ecchymosis of the lids. Rickets may be accompanied by exophthalmos from periosteal proliferation or subperiosteal hemorrhage, but differential diagnosis should not be difficult if one takes into consideration other signs of these diseases.

The pathologic picture of the secondary growths can be confusing, some parts resembling a sarcoma, others a glioma or a scirrhous carcinoma. This marked variation is due to the undifferentiated embryonic elements which make up this malignant tumor.<sup>6</sup> The tumor cells metastasize early, spreading through the lymph and blood vessels, making their appearance in fetal life to give rise to the Pepper type and early in childhood to the Hutchinson type of growth. Neuroblastomas show many cells with dense hyperchromatic nuclei and little cytoplasm. Among these are a few larger round cells with vesicular nuclei and pear-shaped cells resembling young spongioblasts, which have their origin in the undifferentiated parent cell of the sympathetic nervous system.<sup>7</sup> The small cells show a tendency to group themselves in solid masses or in hollow-like spheres called rosettes. A definite rosette-like pattern of the cells makes the diagnosis of neuroblastoma more certain. Wahl

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5. Doub, H. P.: Sympathetic Neuroblastoma, *J. A. M. A.* **109**:1188 (Oct. 9) 1937.

6. Wahl, H. R.: Neuroblastoma, *J. M. Research* **30**:205, 1914.

7. Lewis, D., and Geschickter, C. F.: Tumors of the Sympathetic Nervous System, *Arch. Surg.* **28**:16 (Jan.) 1934.

found them in 50 per cent of his cases and Lewis in 33 per cent of 40 cases.

Treatment is chiefly palliative. Roentgen rays or radium may soften or shrink a tumor mass for a time, but the growth is fatal in one to ten months from the initial signs. Roentgen irradiation is especially indicated in those cases in which there is marked proptosis.

Three children with adrenal neuroblastoma and metastasis to the orbit have been seen in the ophthalmic clinic in the last three years.

#### REPORT OF CASES

CASE 1.—Sophia A., a white child 2½ years of age, was admitted to the University Hospital on Oct. 17, 1936. Two months previous to her admission a swelling



Fig. 1 (case 1).—Photograph of Sophia A. taken on admission to the hospital, showing exophthalmos and swelling in the supraorbital and temporal regions due to metastasis.

was noticed over the right eye, and one month later a swelling appeared over the left eye, associated with a prominence of the globe. A biopsy specimen taken at that time was reported as an endothelioma.

Physical examination revealed an acutely ill undernourished child with a temperature of 102 F. rectally. Tumor masses were palpable through the soft tissue of the scalp and in the region of the right temple extending to the outer margin of the brow. A growth was found on the left extending into the orbit above, pushing the eye forward and mesially. Papilledema was found in each eye. Several firm glands were palpable in the left cervical chain. Studies of the blood showed 32 per cent hemoglobin, 2,000,000 red cells and 14,000 white cells. Roentgenograms of the skull and long bones showed typical changes of neoplastic involvement.

A biopsy specimen was taken from the tumor mass in the right temporal region, and the pathologic diagnosis was a small round cell alveolar neoplasm of sarcomatous or undifferentiated neuroepithelial origin.

The child lost ground rapidly and died on November 19, approximately three months after the swelling was noticed over the left eye.

A limited necropsy was done, and the pathologic diagnosis was as follows: neuroblastoma, primary in the left adrenal gland, and multiple metastases to the skull, left orbit, cervical, peripancreatic, retroperitoneal, paravertebral, iliac, post-auricular and preauricular lymph nodes, left fourth, eighth and tenth ribs, right eighth and tenth ribs and liver.

The liver was found to be studded with multiple white and red areas, the largest being 1.5 cm. in diameter. Microscopic studies showed multiple large and small secondary round cell neoplasms, having a somewhat alveolar arrangement and showing some rosette formation.



Fig. 2 (case 2).—Photograph of Jean V., showing exophthalmos of the left eye with ecchymosis of the upper lid and a tumor mass in the orbital region.

In the superior pole of the left adrenal gland, located in the medulla, there was a hard, white, homogeneous-looking tumor, measuring 1 cm. on each side. The remaining portion of the gland appeared normal.

Microscopically the neoplasm showed marked fibrillary proliferation and ganglion cells with more primitive areas of neuroblastoma cells.

CASE 2.—Jean V., also a white child 2½ years old, was admitted to the hospital on Nov. 9, 1936. Three months before admission the parents had noticed a prominence of the left eye. The child was not acutely ill, and physical examination gave negative results except for the ocular findings. There were ecchymosis of the left upper lid and exophthalmos. A nodular mass was felt in the region of the lacrimal gland.

No abnormality was found on roentgen examination of the skull, chest or long bones.

Several days after the child's admission, the left orbit was approached through the lateral wall, and the frontal bone was found to be involved in a neoplastic



process. In the region of the lacrimal gland a growth extended into the orbit. Biopsy specimens showed undifferentiated cells having the general characteristics of a small round cell sarcoma.

After a course of roentgen therapy to the left orbit, there was a decrease in the proptosis, but the child lost rapidly in weight and strength and died on May 4, 1937, approximately eight months after the onset of the exophthalmos. An autopsy was not performed.

CASE 3.—Donald G., aged 6 years, was first seen on Aug. 8, 1938. Eight months before admission to the hospital he had had an operation for a tumor of the left eye, which was first noticed in December 1937.

Examination showed marked proptosis of the left eye. The vision was nil, and the pupil was widely dilated and fixed. The disk was blurred, and there was fine



Fig. 3 (case 3).—Photograph of Donald G., showing exophthalmos due to metastasis in the orbit.

wrinkling of the retina in the posterior segment. There was a firm nodular mass at the inner and upper angle of the orbit, and the preauricular and cervical lymph glands were enlarged and firm.

Roentgen examination of the orbit showed an intraorbital tumor extending downward through the floor of the orbit to involve the left maxillary sinus and also the adjacent ethmoid cells.

A biopsy specimen was taken from the left nasal chamber, and the pathologic report was as follows: "A small cell, poorly differentiated malignant neoplasm, with many cells slightly spindle shaped and having an alveolar arrangement about the blood vessels. We believe this to be the Hutchinson's type of primitive adrenal neuroblastoma."

Only palliative treatment was indicated, and the child was given roentgen therapy to the left orbit. He lost weight rapidly, became anemic and died in October, ten months after the proptosis was first noticed.

## SUMMARY

Neuroblastomas of the adrenal gland are malignant and arise from the medulla, which is neuroectodermal in origin.

Although there is an occasional overlapping in the two types, it is convenient to classify the symptoms and signs produced by the metastases as the Pepper or the Hutchinson's syndrome.

The ocular findings in the Hutchinson type are caused by metastasis to the orbit and skull.

Differential diagnosis rests mainly on the results of biopsy, roentgen examination and blood studies.

Treatment is only palliative, since the condition is fatal in one to ten months after the onset.

Three cases are reported in which the clinical picture is that of Hutchinson's syndrome.

# EXPERIENCE WITH SULFANILAMIDE IN TREATMENT OF GONORRHEAL OPHTHALMIA

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AND

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Recent advances in chemotherapy have interested many workers in treating a wide variety of diseases with the new drugs. None has received wider attention than sulfanilamide (paraaminobenzenesulfonamide). Following the reports of Long and Bliss <sup>1</sup> that the drug was of value for the treatment of infections caused by streptococci, the work of Dees and Colston <sup>2</sup> in first establishing its value in treating genital gonorrhea suggested that gonorrheal ophthalmia might also respond favorably.

Gonorrheal ophthalmia is most commonly seen in infants and comprises about 50 per cent of the cases of ophthalmia neonatorum. The introduction of the Credé method of prophylaxis reduced the incidence of the latter from approximately 10 per cent to well below 1 per cent.<sup>3</sup> When this method is properly carried out, it is generally admitted that the actual incidence may be extremely low. In 1938 Skeel <sup>4</sup> reported 1 case of gonorrheal ophthalmia to every 290 births in a study of 8,991 newborn infants in Cleveland. Using careful technic in a single hospital, he also reported over 10,000 births without a single instance of gonorrheal ophthalmia. Thus because the Credé prophylaxis is too frequently either neglected or improperly performed, gonorrheal ophthalmia still occurs, and any improvement in treatment should be generally recognized and widely applied.

Rambo <sup>5</sup> advocated the use of a 1 per cent solution of silver acetate in place of silver nitrate. He cited reports from the foreign literature to

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From the Department of Ophthalmology (Dr. Barbour) and the Department of Pediatrics (Dr. Towsley), University Hospital, University of Michigan.

1. Long, P. H., and Bliss, E. A.: Para-Amino-Benzene-Sulfonamide and Its Derivatives, *J. A. M. A.* **108**:32 (Jan. 2) 1937.

2. Dees, J. E., and Colston, J. A. C.: Use of Sulfanilamide in Gonococcic Infections, *J. A. M. A.* **108**:1855 (May 29) 1937.

3. Duke-Elder, W. S.: *Text Book of Ophthalmology*, St. Louis, C. V. Mosby Company, 1938, vol. 2.

4. Skeel, A. J.: Prevention of Gonorrheal Ophthalmia in Newborn, *J. A. M. A.* **111**:143 (July 9) 1938.

5. Rambo, V. C.: Effects of Sulfanilamide as Determined in Eyes of Rabbits, *Am. J. Ophth.* **21**:739 (July) 1938.

establish the fact that the acetate salt is an effective prophylactic for ophthalmia neonatorum.

Because the solubility of silver acetate is 1 Gm. in 100 cc. of water, it is impossible to make up a stronger solution at room temperature than is needed for an infant's eyes. While silver nitrate tends to concentrate by gradual evaporation, silver acetate will crystallize out as soon as the concentration reaches 1.2 per cent. The danger of inadvertently using a silver salt in too strong a concentration would thus be entirely eliminated. The silver acetate is also said to have a less irritant effect. Further trial is recommended by Edward Jackson.<sup>6</sup>

Although the Credé prophylaxis has greatly reduced the incidence of gonorrheal ophthalmia, no similar advance has been made in treatment. Frequent irrigations have long been the most important factor in treatment. Local treatment by the application of antiseptics has proved of little value in changing the course of the disease. Solutions sufficiently strong to kill bacteria cannot be safely applied because of the danger to corneal epithelium. A 1 per cent solution of mercurochrome, a 20 per cent solution of mild protein silver, metaphen in a dilution of 1:2,500 and acriflavine in a dilution of 1:5,000 have not materially affected the outcome of the disease.

Mayou<sup>7</sup> stated that he does not believe that gonococcus vaccines are of significant value, and our limited experiences substantiates his conclusion. Geiger and Burlingame<sup>8</sup> recently reported the use of non-specific foreign protein therapy in the form of typhoid vaccine with favorable results. They reported a significant reduction in discharge and edema within a few days. Duke-Elder<sup>3</sup> stated that this form of treatment is of value only in the early stages.

Hasler and Speker<sup>9</sup> found that artificial hyperthermia produced by physical means shortened the duration of gonorrheal ophthalmia; however, general use of this method seems impracticable.

Since May 1937 sulfanilamide has been used at the University Hospital in all cases in which a diagnosis of gonorrheal ophthalmia is made. Up to the time of this report the drug had been employed in 15 cases

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6. Jackson, E.: Prophylaxis for Ophthalmia Neonatorum, *Am. J. Ophth.* **21**:438 (April) 1938.

7. Mayou, M. S.: Treatment and Prevention of Ophthalmia Neonatorum, *Tr. Ophth. Soc. U. Kingdom* **40**:57, 1920.

8. Geiger, J. C., and Burlingame, R. W.: A Statistical Survey of One Hundred and Forty Cases of Gonorrheal Ophthalmia, *Am. J. Ophth.* **21**:421 (April) 1938.

9. Hasler, W. T., Jr., and Speker, L.: Artificial Fever in the Treatment of Gonorrheal Ophthalmia, *J. A. M. A.* **107**:102 (July 11) 1936.

(table 1). The results in this group will be compared with those obtained in 15 consecutive cases of gonorrheal ophthalmia prior to 1937, before sulfanilamide was employed (table 2). We have also attempted to summarize the results in 55 cases reported by Hageman,<sup>10</sup> Levy,<sup>11</sup> Newman,<sup>12</sup> Willis,<sup>13</sup> L. J. and R. F. Fernandez,<sup>14</sup> Perry,<sup>15</sup> Michels,<sup>16</sup> Glover<sup>17</sup> and Michie and Webster<sup>18</sup> for additional comparison.

#### MATERIAL AND METHOD OF TREATMENT

Only those cases have been included in which the diagnosis of gonorrheal ophthalmia was confirmed bacteriologically by the examination of conjunctival smears. Cultures were positive in most cases. Cases in which the cultures were negative but the smears were positive were accepted if the source of infection was known to be gonorrheal.

Our routine treatment in the 30 cases to be discussed was as follows:

1. Irrigations with warm boric acid solution were given by specially instructed nurses at sufficient intervals to keep the conjunctiva and the cul-de-sac free from discharge. Irrigations were frequently made as often as every thirty minutes.

2. An antiseptic solution was instilled every two to three hours—a 1 per cent solution of mercurochrome, a 20 per cent solution of mild protein silver or metaphen in a dilution of 1:2,500.

3. When corneal involvement was noted, atropine was given in sufficient dose and strength to keep the pupil dilated.

4. Iridectomy, conjunctivoplasty and external canthotomy were done when indicated.

5. Foreign protein in the form of typhoid vaccine or sterile milk was injected in several cases.

6. Silver nitrate—a 1 per cent solution—was employed in a few cases of chronic involvement.

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10. Hageman, P. O.: Clinical Experience in the Use of Sulfanilamide at the New Haven Hospital, *J. Pediat.* **11**:195 (Aug.) 1937.

11. Levy, G. J.: Treatment of Infectious Disease with Sulfanilamide, *Memphis M. J.* **12**:192 (Dec.) 1937.

12. Newman, H. W.: Sulfanilamide in Gonorrheal Ophthalmia in Young Children, *Texas State J. Med.* **33**:585 (Dec.) 1937.

13. Willis, T.: Sulfanilamide in Ophthalmia Neonatorum, *Yale J. Biol. & Med.* **10**:275 (Jan.) 1938.

14. Fernandez, L. J., and Fernandez, R. F.: Sulfanilamide in Gonorrheal Ophthalmia, *Am. J. Ophth.* **21**:763 (July) 1938.

15. Perry, C.: Gonorrheal Conjunctivitis: Treatment with Sulfanilamide and Fever Therapy, *Ohio State M. J.* **34**:176 (Feb.) 1938.

16. Michels, N. W.: Sulfanilamide in the Treatment of Gonorrheal Ophthalmia in Children, *J. Pediat.* **13**:127 (Oct.) 1938.

17. Glover, L. P.: Some Uses of Sulfanilamide in Ophthalmology, *Am. J. Ophth.* **22**:180 (Feb.) 1939.

18. Michie, A. M., and Webster, M. H.: Gonococcal Ophthalmia Treated with 2 (*p*-Aminobenzenesulphonamido) Pyridine, *Lancet* **2**:373 (Aug. 13) 1938.

7. Precautions for the prevention of contagion were employed. All patients were hospitalized in the unit for contagious diseases, where their general condition was followed by members of the department of pediatrics.

8. A patient was discharged after three negative smears were obtained and the discharge ceased.

TABLE 1.—*Summary of Data on Fifteen Consecutive Cases in Which Sulfanilamide Was Used*

| Case | Age of Patient      | Duration of Infection Prior to Admission | Date of Admission | Eye Infected |    | Minimal Discharge, \$ Day | Smears First Negative, Day | Duration of Infection After Admission, Days | Complications After Admission | Final Visual Result        | Average Blood Sulfanilamide Content, Mg. per 100 Cc. |
|------|---------------------|--|-------------------|--------------|----|---------------------------|----------------------------|---|-------------------------------|----------------------------|--|
| (1)  | 9 days              | 5 days                                   | 2/27/37           | +            | +  | 2                         | 3                          | 6   | None                          | Unimpaired after admission | N.D.*  |
| 2    | 5 yr.               | ?  | 5/ 9/37           | 0            | +  | 5                         | 7                          | 9   | None                          | Unimpaired after admission | N.D.   |
| (3)  | 2 mo.               | 7 wk.                                    | 6/11/37           | +            | +  | 6                         | 9                          | 9   | None                          | Unimpaired after admission | 4.3  |
| 4    | 14 mo.              | 7 days                                   | 7/30/37           | +            | +  | 6                         | 9                          | 11  | None                          | Unimpaired after admission | 11.2   |
| (5)  | 20 days (premature) | ?  | 11/30/37          | +            | +  | 6                         | 6                          | 9   | None                          | Unimpaired after admission | 32.0   |
| (6)  | 7 days              | 4 days                                   | 12/14/37          | 0            | +  | 5                         | 6                          | 8   | None                          | Unimpaired after admission | 17.3   |
| (7)  | 21 days             | 14 days                                  | 2/24/38           | +*           | +† | 6                         | 8                          | 11  | None                          | Unimpaired after admission | 18.4   |
| 8    | 1 yr.               | 4 days                                   | 2/24/38           | +            | +* | 4                         | 4                          | 6   | None                          | Unimpaired after admission | 12.5   |
| 9    | 16 yr.              | 3 days                                   | 3/ 2/38           | +†           | 0  | 7                         | 4                          | 12  | None                          | Unimpaired after admission | 14.2   |
| (10) | 2 mo.               | 6 wk.                                    | 8/28/38           | +            | +  | 4                         | 3                          | 7   | None                          | Unimpaired after admission | N.D.   |
| (11) | 21 days             | 9 days                                   | 10/11/38          | +            | +  | 4                         | 3                          | 9   | None                          | Unimpaired after admission | 4.4  |
| (12) | 5 days              | 2 days                                   | 12/ 9/38          | +            | +  | 5                         | 3                          | 9   | Ulcers in each eye            | Unimpaired after admission | N.D.   |
| 13   | 13 mo.              | 9 days                                   | 1/ 6/39           | +†           | +  | 9                         | 4                          | 11  | None                          | Unimpaired after admission | N.D.   |
| (14) | 11 days             | ?  | 2/19/39           | 0            | +  | 2                         | 2                          | 4   | None                          | Unimpaired after admission | 5.2  |
| 15   | 20 yr.              | 12 hr.                                   | 2/25/39           | +            | +  | 1                         | 1                          | 3   | None                          | Unimpaired after admission | 6.8  |

\* The cornea was slightly hazy on the patient's admission.

† The cornea was ulcerated on the patient's admission.

‡ The cornea was perforated on the patient's admission.

§ The discharge was considered minimal when irrigations were required three times daily or less.

# N.D. means no determination was made.

Identical local care was given the patients in the two groups. Sulfanilamide was administered by mouth, except to 1 infant, to whom a 0.5 per cent solution in physiologic solution of sodium chloride was given subcutaneously. No important feeding problems were encountered. Equal amounts of sodium bicarbonate were used in a few cases. Doses were decreased as improvement or signs of toxicity were noted. The sulfanilamide content of the blood was determined after the

TABLE 2.—Summary of Data on Fifteen Consecutive Cases in Which Treatment Was Given Prior to 1937, Before Use of Sulfanilamide

| Case | Age of Patient | Duration of Infection Before Admission | Date of Admission | Eye Infected |      | Special Treatment      | Minimal Discharge, Day | Smears First Negative, Day | Duration of Infection After Admission, Days | Complications After Admission   | Final Visual Result            |
|------|----------------|--|-------------------|--------------|------|------------------------|------------------------|----------------------------|---|---------------------------------|--------------------------------|
|      |                |  |                   | Right        | Left |                        |                        |                            |   |                                 |                                |
| ①    | 12 days        | 5 days                                 | 10/20/33          | +            | ++   | None                   | 28                     | 30                         | 39  | Corneal perforation, left eye   | Nil, left eye                  |
| ②    | 10 days        | 7 days                                 | 1/ 5/34           | +            | +    | None                   | 25                     | 35                         | 42  | None                            | No impairment after admission  |
| ③    | 17 days        | 13 days                                | 4/13/34           | +            | +    | None                   | 13                     | 13                         | 16  | None                            | No impairment after admission  |
| ④    | 3 days         | 2 days                                 | 7/19/34           | +            | +    | None                   | 15                     | 18                         | 21  | None                            | No impairment after admission  |
| ⑤    | 16 days        | ?                                      | 7/24/34           | +            | +    | None                   | 15                     | 35#                        | 38  | Ulcer in each eye               | Corneal nebula, right eye      |
| ⑥    | 6 wk.          | 1 mo.                                  | 7/26/34           | +            | ++   | None                   | 10                     | 18                         | 23  | None                            | Perception of light, left eye  |
| 7    | 20 yr.         | 3 days                                 | 9/ 5/34           | 0            | +    | Typhoid vaccine        | 7                      | 10                         | 14  | None                            | No impairment after admission  |
| 8    | 33 yr.         | 3 days                                 | 12/21/34          | +            | +    | Typhoid vaccine        | 11                     | 7                          | 26  | Ulcer in each eye               | Perception of light, right eye |
| ⑨    | 5 days         | 3 days                                 | 1/ 6/35           | +            | +    | None                   | 40                     | 50                         | 55  | Corneal perforation in each eye | Moving objects, each eye       |
| 10   | 10 yr.         | 14 days                                | 3/15/35           | 0            | ++   | Typhoid vaccine        | 16                     | 18                         | 21  | None                            | 1/60, left eye                 |
| ⑪    | 12 days        | 2 days                                 | 6/14/35           | 0            | +    | None                   | 15                     | 28                         | 31  | None                            | No impairment after admission  |
| ⑫    | 21 days        | 20 days                                | 11/19/35          | +            | +    | None                   | 25                     | 29                         | 32  | None                            | No impairment after admission  |
| 13   | 9 yr.          | 2 days                                 | 4/ 8/36           | 0            | +    | Corbus-Ferry filtrate§ | 30                     | 34                         | 37  | Ulcer in each eye               | 6/6, left eye                  |
| 14   | 14 yr.         | 8 days                                 | 12/14/36          | 0            | ++   | Typhoid vaccine        | 15                     | 20                         | 23  | None                            | 6/9, left eye                  |
| ⑬    | 3 days         | 2 days                                 | 2/ 6/37           | +            | +    | None                   | 33                     | 38                         | 42  | Corneal perforation in each eye | Nil, each eye                  |

\* The cornea was slightly hazy on the patient's admission.

† The cornea was ulcerated on the patient's admission.

‡ The cornea was perforated on the patient's admission.

§ This filtrate is prepared from cultures of *Micrococcus gonorrhoeae*. It contains no bacterial bodies and is used intradermally.

|| The discharge was considered minimal when irrigations were required three times daily or less.

# The smears were positive fifteen days after admission.

method of Marshall.<sup>19</sup> These determinations were made on alternate days when possible. The concentration of the blood was used as an indicator for the quantity of drug to be given, and an attempt was made to maintain it at approximately 10 mg. per hundred cubic centimeters. In general, 2 to 3 grains (0.13 to 0.19 Gm.) per pound of body weight was used for infants during each twenty-four hours and 1½ grains (0.09 Gm.) per pound for older children and adults.

The patients were carefully observed for evidence of toxicity. This included temperature readings every four hours and careful observations of respiratory rate, cyanosis, gastric distress and diarrhea, especially in newborn infants. A white blood cell count and hemoglobin determinations were made on alternate days.

#### REVIEW OF RESULTS

It has been wisely said that the degree of vision retained after the infection has subsided is the important test of the efficiency of any

TABLE 3.—*Summary of Data*

|  | Treatment<br>Prior to Use of<br>Sulfanilamide<br>(15 Cases) | Treatment<br>with<br>Sulfanilamide<br>(15 Cases) | Treatment with<br>Sulfanilamide<br>(55 Cases from<br>Literature) |
|--|---|--|--|
| Average duration of infection prior to starting sulfanilamide .....                                  | 8.1 days  | 12.3 days  | 7.6 days   |
| Average number of days after starting sulfanilamide on which first negative smear was obtained ..... | 25.5  | 4.8  | 5.0  |
| Average number of days before discharge was minimal .....  | 19.9  | 4.8  | 4.8  |
| Average duration of disease after treatment was started, days .....                                  | 30.7  | 8.3  | 8.7  |
| Number of cases in which corneal ulcers developed during treatment.....                              | 5   | 1  | 2  |
| Number of cases in which significant visual loss occurred .....                                      | 4   | 0  | 0  |
| Average concentration of sulfanilamide in blood, mg. per 100 cc. ....                                | ..  | 12.4   | 6.4  |

method used to treat gonorrheal ophthalmia. In only 1 of the 15 cases (no. 12) in which sulfanilamide was used did corneal ulcers develop after the administration of the drug was started. These remained very superficial and healed rapidly with only tiny residual nebulae. Since of the 55 cases (table 3) summarized from the literature there was none in which significant visual loss occurred after the administration of sulfanilamide was started, this makes a total of 70 cases in which serious corneal complications did not occur. Corneal ulcers developed in 5 of the 15 cases in the control group (table 2) after treatment was started. In 3 of these (nos. 5, 8 and 15) there was a slight haze to the involved cornea when the patients were admitted to the hospital; in 2, it progressed to perforation with vision limited to perception of light or worse. The patient in case 5 was discharged with useful vision. The patients in cases 9 and 13 had a clear cornea on admission; however, the ulcers

19. Marshall, E. K.: Determination of Sulfanilamide in Blood and Urine, J. Biol. Chem. **122**:263 (Dec.) 1937.



in case 9 perforated, resulting vision being limited to perception of moving objects, and in case 13 slow healing occurred, with resulting vision of 6/6. Thus in 2 of the 15 control cases (both in infants) useful vision was lost in both eyes.

Wharton<sup>20</sup> in an analysis of 13,722 cases, reported corneal ulcers in 13 per cent with perforation in 12.8 per cent of this number. According to a recent report,<sup>8</sup> corneal ulcers developed in 27 per cent of 59 cases. This incidence was reduced to 13 per cent in 68 cases by the use of foreign protein therapy in the form of typhoid vaccine. It is interesting to note that 11 relapses occurred in the later group. Since each corneal ulcer indicates a potentially blind eye, the decreased incidence of this complication is an important economic and sociologic factor.

The clinical improvement noted after the administration of sulfanilamide was started was frequently dramatic, as illustrated in case 14. On the patient's admission to the hospital the right eye was normal. The left eyelids were extremely edematous, and there was much copious discharge. The cornea could be seen only by using a lid hook and was normal. Smears and cultures were positive. One gram of sulfanilamide was given on admission, and this dose was repeated in one hour. Five-tenths gram was then given every eight hours. Twenty-four hours after the patient's admission, discharge and edema were decreased markedly. Organisms were rare on the stained smear, and the culture was negative. The cornea could be exposed with ease. Twenty-four hours later the eye was almost normal. Smears and cultures were negative. Two days later the baby was ready for discharge.

No recurrence of discharge was noted in the group of cases in which sulfanilamide was used. Of the 55 cases reviewed, inconsequential recurrence of discharge occurred in only 1 of those in which treatment was adequate. In 2 cases the drug was temporarily discontinued, in 1 because of toxicity, causing a hemolytic anemia (Willis<sup>13</sup>); in both there was a moderately severe recurrence of discharge. The hemolytic anemia readily responded to transfusion, and the drug was again given with satisfactory results.

Smears once negative remained negative in this series and in the group reported from the literature. In no case in either group was there a persistent positive smear after the discharge had ceased. In case 4 in the control group positive smears were obtained fifteen days after the discharge had ceased. Mayou<sup>7</sup> pointed out that virulent gonococci have been found twenty-eight days after all discharge had stopped. This point is significant from the standpoint of cross infection and reinfection.

20. Wharton, cited by Duke-Elder.<sup>3</sup>

In 10 of the 30 cases the infection was monocular. A Buller's<sup>21</sup> shield prevented cross infection in each instance.

As noted in table 3, the average duration of the disease in the control group was almost four times as long as in the group in which sulfanilamide was used. It took approximately four times as long for the discharge to become minimal in the control group. This means a substantial saving in the cost of hospitalization.

It is difficult to evaluate the effect of nonspecific foreign protein therapy in the cases presented. Its use was generally limited to children and adults with corneal complications. With few exceptions, typhoid vaccine was used. The objections of Hektoen<sup>22</sup> to the use of milk because of specific sensitivity seems valid. The clinical improvement in the disease noted by Geiger and Burlingame<sup>8</sup> and others tends to establish the fact that typhoid vaccine does have a place in the treatment. Our experience in combining sulfanilamide therapy with foreign protein therapy is too limited to conclude as to the value or possible complications. We would be reluctant to use the two forms of treatment simultaneously for infants; however, they might be safely combined for adults if the patient is carefully followed.

The patient in case 15 received 14 Gm. of sulfanilamide by mouth and one intravenous injection of 25,000,000 killed typhoid organisms during the first forty-eight hours, without apparent ill effect. There was practically no discharge twelve hours after the patient's admission. This was the most rapid improvement noted. There seems to be no evidence to contraindicate their combined use, which is acceptable from a theoretic point of view, as nonspecific foreign protein is known to stimulate the bodies' defense mechanism,<sup>22</sup> while sulfanilamide is thought to act by decreasing the rate of multiplication of the bacteria or by diminishing the invasive power of the organisms.<sup>23</sup> From the evidence available, sulfanilamide is certainly the treatment of choice.

The average daily dose of sulfanilamide during the first three days was  $2\frac{7}{10}$  grains (0.175 Gm.) per pound for the patients under 1 year of age and  $1\frac{6}{10}$  grains (0.103 Gm.) per pound in those above 1 year of age. Higher doses were required for infants to maintain adequate

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21. Buller, F.: A Protective Bandage for the Eye, *Lancet* **1**:690 (May 16) 1874.

22. Hektoen, L.: Reactions of the Non-Specific Protein Treatment of Infectious Diseases, *J. A. M. A.* **105**:1765 (Nov. 30) 1935.

23. Lockwood, J. S.; Coburn, A. F., and Stolinger, A. F.: Studies on the Mechanism of the Action of Sulfanilamide: Bearing of the Character of the Lesion on the Effectiveness of the Drug, *J. A. M. A.* **111**:2259 (Dec. 17) 1938. Long, P. H.; Bliss, E. A., and Feinstone, W. H.: Mode of Action, Clinical Use and Toxic Manifestations of Sulfanilamide, *ibid.* **112**:115 (Jan. 14) 1939.

blood levels of the drug. In our later cases we have attempted to give a large initial dose in order to reach an effective level as rapidly as possible.

In only 1 case did a toxic symptom develop that was severe enough to warrant discontinuing the use of the drug. This was an extremely severe cyanosis, thought to be due to the drug. Moderate cyanosis was the rule. Significant fever, dermatitis, agranulocytosis, hemolytic anemia, jaundice or acidosis did not occur. Since toxic symptoms can occur rapidly and have been fatal, every patient receiving sulfanilamide is entitled to careful clinical observation for evidence of intoxication.

Because of the limited number of cases which have come under our observation, we have not used the drug by local instillation into the cul-de-sac. Rambo<sup>5</sup> reported that the eye will tolerate a 0.5 per cent aqueous solution of sulfanilamide, repeatedly instilled, without reaction. Glover<sup>17</sup> used it locally and orally in treating gonorrheal ophthalmia but does not conclude as to the relative value of each method. Engelfried<sup>24</sup> showed that the drug is rapidly diffused throughout the tissues after oral administration.

Since the drug is excreted in the urine in an unchanged form, it is logical to expect that local application would be of value.

We have had no experience using compounds closely related chemically to sulfanilamide in gonorrheal ophthalmia.

#### CONCLUSION

Our experience in treating gonorrheal ophthalmia with sulfanilamide has been reviewed and evaluated. Our results have been compared with those in other cases reported in the literature. The drug is a definite advance in therapy for the following reasons:

1. The incidence of corneal complications has been reduced.
2. Hospitalization has been reduced to an average of eight and three-tenths days.
3. Under careful supervision, the drug can be given with a minimum of complications.
4. Newborn infants tolerate and require larger quantities of the drug than adults to raise the blood concentration to the expected level.

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24. Engelfried, J. J.: Observations on Absorption, Distribution and Excretion of Sulfanilamide in Normal Rabbits: Preliminary Report, Univ. Hosp. Bull., Ann Arbor 4:4 (Jan.) 1938.

# OCULAR ICHTHYOSIS

## REPORT OF A CASE

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The association of corneal and conjunctival lesions with certain diseases of the skin, such as acne rosacea and eczema, is well recognized. Ocular involvement in cases of ichthyosis is sufficiently rare, however, to warrant presentation of a case together with a brief review of the literature.

## REPORT OF CASE

M. B., a 24 year old housewife, was admitted to the ophthalmic clinic of the University of California on Sept. 2, 1938. For the previous nine years she had suffered from redness, irritation and watering of the eyes, which in the past five years had been accompanied by a severe and persistent photophobia. In the last six months there had been diminution of vision in the right eye.

The patient had been a deaf-mute since birth, and at the age of 2 years a generalized ichthyosis of the skin developed, which persisted. Occurrence of either deaf-mutism or of ichthyosis in any of the other members of her family was unknown.

Examination revealed vision of 20/30 in the right eye and 20/20 in the left eye. Marked photophobia, blepharospasm and epiphora were present in each eye.

There was fine scaling, with some hypertrophy, on the skin of the lids of the right eye. Only a few fine hairs of the eyebrow remained. The cilia were scanty and projected only a short distance from the surface. There was scaling and marked redness of the margins of the lids. When the lids were everted the palpebral conjunctiva was seen to be markedly red, smooth and hypertrophied. These changes were most evident on the lower lid and least marked in the fornices. Slight congestion, without hypertrophy, was present in the bulbar conjunctiva. Large, dilated conjunctival vessels extended into the cornea, forming a markedly vascularized, pannus-like growth covering the lower three fifths of the cornea. It was sharply demarcated from the normal cornea above by a slightly raised, irregular border. Below, the growth passed uninterruptedly into the conjunctiva and the sclera.

Examination with the corneal microscope revealed the growth to occupy the subepithelial region and superficial portion of the substantia propria and its vascular supply to be derived from both the anterior ciliary and the conjunctival vessels. Between the vascular loops the corneal substance was uniformly cloudy and infiltrated. The deeper portions of the cornea, anterior chamber and iris seemed unaffected. There were no changes in the media or fundus.

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External examination of the left eye revealed changes similar to those noted in the right eye, with the exception of the cornea. This structure was almost entirely clear, showing only a few tiny conjunctival vascular loops passing 1 to 2 mm. into the corneal substance from below. The corneal microscope revealed no opaque corneal nerves.

Dermatologic examination showed a generalized ichthyosis, with dryness, scaling, thickening and slight fissuring of the skin of the scalp, forehead, ears and cheeks. Deep fissures, similar to rhagades, radiated from the angles of the mouth.

Biopsy of a specimen of skin revealed the pathologic changes of a congenital keratoderma.

General physical examination evidenced no additional abnormalities. The blood pressure was 100 systolic and 60 diastolic. The basal metabolic rate was  $\pm$  19 per cent. The Wassermann and Kahn tests were negative. A complete blood count showed no eosinophilia. There was persistence of the upper second deciduous teeth with congenital absence of the permanent bicuspid.

For two months the patient used astringent medications at home, while in the clinic a 2 per cent solution of quinine bisulfate was applied to the everted lids twice a week. This regimen resulted in no symptomatic or objective changes. Other treatment also was ineffective. Three months after the patient's entry to the clinic the vision in the right eye was reduced to 20/70 by the upward progression of the corneal growth. At this time peritomy was performed, a strip of conjunctiva 1 mm. broad being excised all around the limbus, but without beneficial effect. We have recently commenced coagulation of the larger vessels near the limbus, after the method described by Gundersen,<sup>1</sup> which may prove beneficial; however, it is too early to know the effect.

#### REVIEW OF THE LITERATURE

Ichthyosis of the skin is defined as a congenital cutaneous disease characterized by a dry, harsh, scaly condition, associated with abnormal cornification.<sup>2</sup> It may be present at birth or may develop shortly afterward, or in some instances its appearance may be delayed until adolescence. Heredity plays an important role, as many instances of familial tendency have been recorded. There is no sexual predisposition. Postmortem examination in 1 case of congenital ichthyosis revealed changes in the thyroid and adrenals, which suggests an endocrine origin.<sup>3</sup> The general consensus is that it is a local congenital defect in the nutrition of the skin affecting the epidermis and the fatty layers.

In rare instances ichthyosis may involve the skin of the face and eyelids. In these cases the face shows areas of typical dry scaling with thickening and formation of fissures. This same process may

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1. Gundersen, T.: Vascular Obliteration for Various Types of Keratitis: Its Significance Regarding Nutrition of the Corneal Epithelium, *Arch. Ophth.* **21**:76 (Jan.) 1939.

2. Ormsby, O. S.: A Practical Treatise on Diseases of the Skin, ed. 5, Philadelphia, Lea & Febiger, 1937, p. 540.

3. Kingery, L. B.: Ichthyosis Congenita with Unusual Complications, *Arch. Dermat. & Syph.* **13**:90 (Jan.) 1926.

extend to the skin of the lids. The bases of the cilia are covered with white, firmly adherent scales which interfere with their normal growth and development. Piling up of epithelium together with hyperpigmentation at the roots of the cilia was present in the case presented by Komoto.<sup>4</sup>

Severe involvement of the lids and facial skin may cause marked ectropion, with resultant lagophthalmos and danger to the cornea. This type is well illustrated by Sondermann's case.<sup>5</sup>

Milder conjunctival changes may occur without ectropion, as shown in our case. The palpebral conjunctiva of the lower lids of Buller's<sup>6</sup> second patient was swollen and glazed, with several longitudinal ridges and without follicles. The conjunctiva of the upper lids showed a remarkable glazed, varnished appearance. There were flattened granules, irregular in size and shape, varying from 1 to 2 mm. in diameter and quite hard when incised. Komoto<sup>4</sup> described a papillary overgrowth in addition to the other changes in the conjunctiva. Aside from the foregoing pathologic process, the bulbar conjunctiva may show marked thickening and infiltration, extending into the episcleral tissue.

According to Kraupa,<sup>7</sup> changes may be detected with the corneal microscope even in the absence of gross visible conjunctival or corneal disease. He found the corneal nerves to be roughened and translucent, with their finest branchings visible. The terminal filaments ended in "brushes" and small star-shaped figures, while along the roughened fibers appeared small chalky white deposits. Kraupa<sup>8</sup> reported 4 cases of ichthyosis in which there were no ocular symptoms. Two of the patients had corneal changes which were visible only with the slit lamp. Another had opacities which were visible with the loupe and resolved themselves into a fine stippling together with small lines, the appearance being not unlike that of a sanded glass plate. The fourth patient had fine opacities of a patchy type extending from the center toward the periphery but stopping short of the limbus. In all of the foregoing cases the corneal lesions caused no interference with vision. In rare cases the disease involves the cornea directly and produces a faint gray opacification of the parenchyma.

More extensive involvement of the cornea, sufficient to cause loss of vision, at times definitely associated with pannus formation, may also occur. Komoto's<sup>4</sup> patient had an unusual corneal change in that a thick white growth extended from above and below toward the

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4. Komoto, J.: *Klin. Monatsbl. f. Augenh.* **47**:259, 1909.

5. Sondermann, G.: *Klin. Monatsbl. f. Augenh.* **70**:180, 1923.

6. Buller, F.: *Tr. Am. Ophth. Soc.* **4**:582, 1887.

7. Kraupa, E.: *Klin. Monatsbl. f. Augenh.* **70**:396, 1923.

8. Kraupa, E.: *Klin. Monatsbl. f. Augenh.* **65**:903, 1920.

center, leaving the central portion clear. This was a leukoplakic thickening, marked by fine fissures and intervening elevations running parallel to each other.

The symptoms are dependent on the ocular structures involved and the extent of the lesions. In the cases of mild involvement there may be no symptoms, while patients with more extensive conjunctival and corneal involvement may have marked photophobia, blepharospasm, epiphora and diminution of vision.

The possible causation of the corneal changes has been described by Kraupa,<sup>7</sup> who considered them the result of dystrophy of the deeper corneal cells, having a neurotrophic origin. He expressed the belief that this neurotrophic change is a result of inheritance of a constitutionally abnormal cornea. In support of this, he pointed out that families of patients suffering from this disease are likely to show neuropathic diatheses. In one of the families the mother suffered from loss of hearing, while a brother had ocular torticollis due to paralysis of the trochlear nerve and exhibited a single diseased corneal nerve. Komoto<sup>4</sup> expressed the opinion that secondary changes are brought about in the cornea mechanically by friction from inflamed lids. The small scales which are at times seen superficially on the cornea must be regarded as corresponding to the scales on the skin.

Pathologic reports of the corneal and conjunctival lesions are limited. The earliest is that of Buller,<sup>6</sup> who excised several papillae from the conjunctiva of the lower lid and found that they were composed of granulation tissue, containing a large proportion of white fibrous tissue. This fibrous tissue was in the form of wavy bands with cellular elements predominating in many areas. Komoto<sup>4</sup> obtained biopsy specimens from his patient. These showed the palpebral conjunctiva to be markedly thickened throughout as a result of cellular infiltration and epithelial hyperplasia. In the fornices there was only slight epithelial thickening. Marked thickening and infiltration were present in the bulbar conjunctiva, extending into the episcleral tissue. The epithelium was four to five times its normal thickness, was not uniform and in places seemed wartlike. The corneal changes were similar to those seen in the bulbar conjunctiva except for additional fissuring, in which ran tiny sub-epithelial blood vessels. Bowman's membrane was everywhere absent.

The diagnosis in these cases should cause little difficulty because of the coexistent cutaneous manifestations. Kraupa<sup>9</sup> brought out an important differentiation between the type in which the corneal nerves only are involved and familial corneal disease. He stated that the latter tends to be progressive, mainly involves the corneal nerves and

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9. Kraupa, E.: *Klin. Monatsbl. f. Augenh.* **73**:229, 1924.

is not accompanied by a cutaneous disease, while the former is not progressive, mainly involves the corneal cells and is accompanied by ichthyosis of the skin.

Owing to the congenital nature of the disease, treatment is unsuccessful and cure impossible. Buller<sup>6</sup> treated his second patient for one year without success. Komoto<sup>4</sup> excised the thickened white corneal keratosis, with great relief to the patient. One year later there was no recurrence of the keratosis, and the vision was improved. Sondermann<sup>5</sup> emphasized the necessity of early autoplasmic transplantations of skin for those patients with ectropion, as corneal desiccation and ulceration are much more likely to occur than when the cornea is normal. Elschmig<sup>10</sup> reported a good result in the treatment of ectropion with transplantation of skin from an unaffected sister. The recent report of Gundersen<sup>1</sup> offers hope, at least in our case, of preventing the spread of corneal vascularization.

#### SUMMARY

A case of generalized ichthyosis of the skin associated with ocular ichthyosis is presented, in which there were bilateral involvement of the conjunctiva and involvement of the right cornea. The conjunctival changes consisted of thickening and marked redness without papillary or follicular formation. The right cornea showed a pannus and infiltration extending from the lower limbic region into the center of the cornea. The pannus and infiltration were probably secondary to the conjunctival lesions.

Involvement of the ocular tissues in cases of ichthyosis of the skin is rare and may occur in several forms:

(a) There may be asymptomatic involvement of the cornea in the nature of a dystrophy of the corneal cells and nerves. This form is seen only with the slit lamp or other means of magnification.

(b) There may be an inflammatory form, showing smooth or papillary hyperplasia of the conjunctiva, with involvement of the cornea due to mechanical irritation, which causes secondary changes.

(c) The cornea may be involved primarily by a keratosis in which the scales correspond to the scales present in the dermatologic lesions.

A thorough study of the corneas of all persons suffering from ichthyosis should be made, as the asymptomatic type can easily be overlooked.

Therapy of ocular ichthyosis is limited to symptomatic measures. Complications, especially ectropion, should be treated as they arise. Coagulation as described by Gundersen may be helpful.

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10. Elschmig, A.: *Klin. Monatsbl. f. Augenh.* **71**:155, 1923.



# DARK ADAPTATION, NIGHT BLINDNESS AND GLAUCOMA

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Laboratory experiments on animals have definitely shown an association between avitaminosis A and delayed regeneration of the visual purple.<sup>1</sup> Observations during the Lenten fasts in Russia and in the European countries during the World War have verified these findings in man. I have often been able to corroborate the results of the animal experiments indirectly in patients on relief and deprived of normal diet on whom I have done dark adaptation studies.

That the liver is the storehouse of vitamin A<sup>2</sup> is the accepted opinion. It would therefore appear that since the liver plays such an enormous role in the metabolism of the body, avitaminosis A might affect the metabolism of the liver to some extent.

Studies have been made on patients with renal calculi,<sup>3</sup> various glandular disturbances<sup>4</sup> and other diseases wherein the metabolism was disturbed. An effort was made to find what association there is between these diseases and the behavior of dark adaptation. Many of these patients had pathologic dark adaptation and a few even suffered with night blindness.

My present study includes cases of idiopathic night blindness, i. e., night blindness without any known constitutional disease accountable

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1. Fridericia, L. S., and Holm, E.: Experimental Contribution to the Study of the Relation Between Night Blindness and Malnutrition: Influence of Deficiency of Fat-Soluble A Vitamin in Diet on Visual Purple in the Eyes of Rats, *Am. J. Physiol.* **73**:63, 1925.

2. Wolff, L. K.: On the Quantity of Vitamin A Present in the Human Liver, *Lancet* **2**:669, 1932. Moore, T.: Vitamin A and Carotene: The Vitamin A Reserve of the Adult Human Being in Health and Disease, *Biochem. J.* **31**:155, 1937.

3. Ezickson, W. J., and Feldman, J. B.: Signs of Vitamin A Deficiency in the Eye Correlated with Urinary Lithiasis: Report of Clinical Studies and Investigations on Twenty-Five Patients, *J. A. M. A.* **109**:1706 (Nov. 20) 1937.

4. Wohl, M. G., and Feldman, J. B.: Vitamin A Deficiency in Disease of the Thyroid Gland: Its Detection by Dark Adaptation, *Endocrinology* **24**:389, 1939.

for the condition. I tried to determine what relation, if any, there is between pathologic dark adaptation and night blindness. I wanted to find how amenable the latter condition is to cure. Lastly, since glaucoma, in the majority of cases is associated with pathologic dark adaptation, an attempt was made to correlate the frequency of night blindness in this condition. I have noted my observations in a few cases of glaucoma with relation to cholesterol metabolic disturbance.

#### DARK ADAPTATION

*Technic.*—The technic by which these studies were made was the same as that given in my previous papers.<sup>5</sup> Attention was paid to the following points: (1) complete ophthalmologic examination of each patient, (2) control of the pupillary area by miotics, (3) character and constancy of the "preexposure" and "light stimulus," (4) area of the retina examined and (5) plotting of the dark adaptation curve.

The plotting of the curve on the dark adaptation chart gives the intensity of light in photons as the ordinates and the time at which each light threshold was taken as the abscissas. This makes it possible to evaluate easily the cone<sup>6</sup> from the rod adaptation and the exact time in minutes of dark adaptation at which each phenomenon took place.

*Adaptation.*—Pure rod adaptation<sup>7</sup> is below 0.00025 photon. Cone adaptation is noted when the light threshold is over 0.025 photon. The combination of cone and rod adaptation is noted when the light threshold lies between 0.025 and 0.00025 photon. From a clinical standpoint, what concerns the observer most is the nature of the curve of dark adaptation and the final light threshold, which latter should be at or below 0.000150 photon within thirty minutes.

*Precaution.*—The study of dark adaptation is a subjective one; therefore the unintelligent, sick or apprehensive patient may, while having a dark adaptation study done, sometimes wait until the light becomes quite intense (more so than the person's actual light threshold) before he denotes that he sees it. This light threshold may therefore erroneously be ascribed to marked cone adaptation by the examiner, when in truth the patient's actual threshold is not nearly so intense.

When, for some particular reason, it is desirable to demonstrate cone adaptation, it is to be remembered that prolonged "preexposure" (light adaptation for ten minutes) over the three minutes, which I usually give, and the taking of frequent readings during the first ten minutes of dark adaptation tends to bring out cone adaptation better.

5. Feldman, J. B.: (a) Dark Adaptation as a Clinical Test: Further Studies, *Arch. Ophth.* **17**:648 (April) 1937; (b) Practice of Dark Adaptation: Review, *ibid.* **19**:882 (June) 1938.

6. Hecht, S.: Rods, Cones and the Chemical Basis of Vision, *Physiol. Rev.* **17**:239, 1937.

7. Tansley, K.: The Regeneration of Visual Purple: Its Relation to Dark Adaptation and Night Blindness, *J. Physiol.* **71**:442, 1931.

However, for a few patients I have found the first few readings (cones) much lower when the dark adaptation study was repeated on a later occasion. The patient had gained more experience and knew better what was desired. This repetition of the dark adaptation study, however, did not materially affect the curve of dark adaptation or the final thirty minute threshold reading.

#### NIGHT BLINDNESS

Except in the organic type of pathologic dark adaptation, as found in cases of retinitis pigmentosa, choroiditis and glaucoma, all types of functional or latent night blindness may in general be said to be due to avitaminosis A. These may be divided into three groups as follows: (1) night blindness due to avitaminosis A and caused by lack of proper food balance or intake, (2) night blindness associated with a glandular disease or some other constitutional disease which possibly indirectly causes avitaminosis A and (3) idiopathic night blindness in which the fundus, as in all cases of functional night blindness, is normal and there is no definite cause for the condition.

1. Latent avitaminosis A, as seen in the United States, is often accompanied by moderate night blindness. Actually, none of the serious symptoms, such as xerophthalmia and keratomalacia, are hardly ever encountered, because the condition is usually not permitted to become so advanced in this country.

2. The symptom night blindness accompanies systemic disease more often than has heretofore been supposed, and I have found it occasionally in association with renal calculi, thyroid dysfunction and hepatic diseases.<sup>8</sup>

3. The treatment of idiopathic night blindness with vitamin A with final cure leads me to believe that avitaminosis A is an exciting factor in this condition.

*Dark Adaptation.*—One would assume that since dark adaptation is the study of night blindness, the more pathologic the dark adaptation the more severe the night blindness. This, however, is not always the case, as is illustrated in the accompanying chart, wherein are shown the dark adaptation curves for 3 patients who were night blind. Also shown are the pathologic dark adaptation curves for 2 patients who were not night blind. The data pertaining to the 3 patients who were night blind are presented in table 1.

8. (a) Wohl, M. G., and Feldman, J. B.: Dark Adaptation Studies in Liver Diseases, J. Lab. & Clin. Med., to be published. (b) Ezickson, W. J., and Feldman, J. B.: Further Studies of Vitamin A Deficiency in Individuals with Urinary Lithiasis, Urol. & Cutan. Rev. 43:302, 1939.

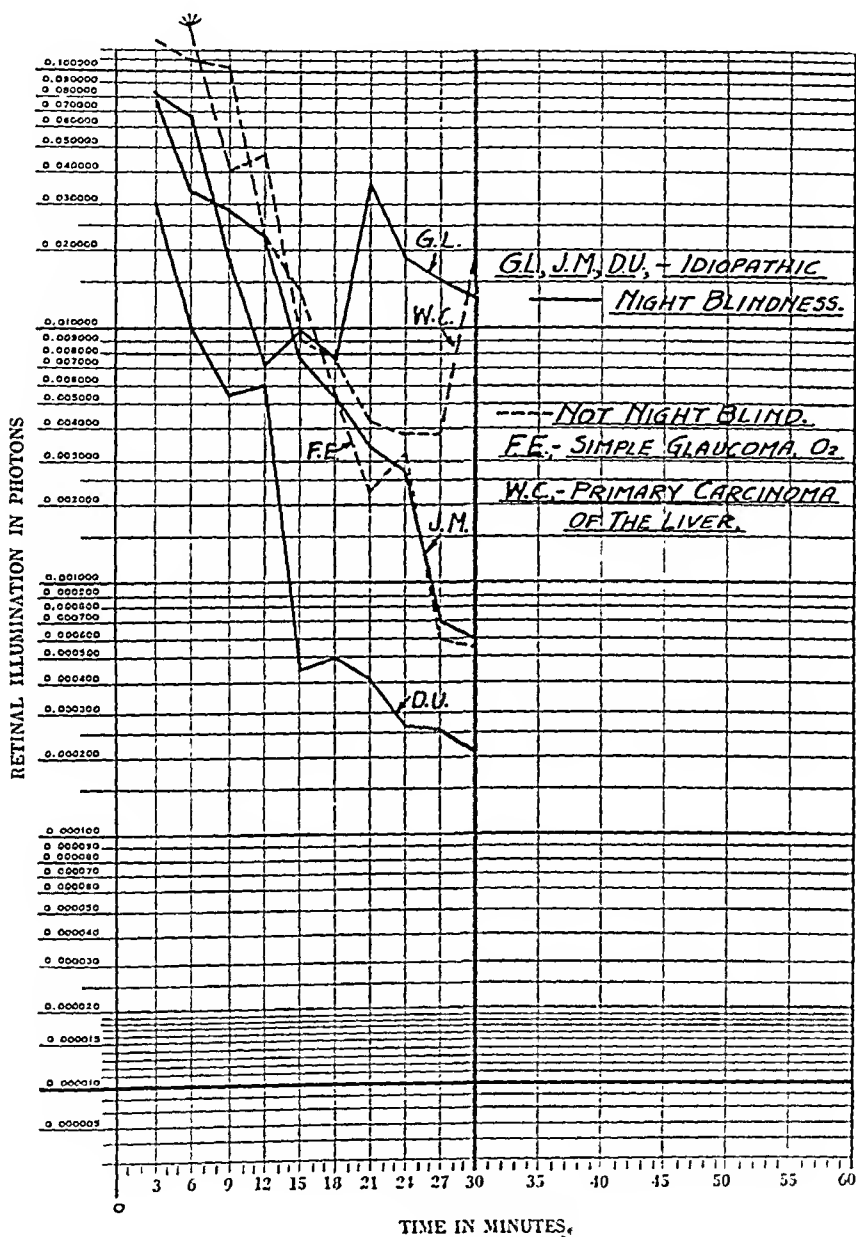
TABLE 1.—Data on Three Patients with Night Blindness

| Initials<br>of<br>Patient | Age | Sex | Vision |       |  | Duration | Urine                              | Blood Study*          |                       |                         |                                       |                             | Blood Chemistry                     |  |   |   | Dark<br>Adapta-<br>tion† |
|---------------------------|-----|-----|--------|-------|--|----------|------------------------------------|-----------------------|-----------------------|-------------------------|---------------------------------------|-----------------------------|-------------------------------------|--|---|---|--------------------------|
|                           |     |     | O. D.  | O. S. |  |          |                                    | Red<br>Blood<br>Cells | Hemo-<br>globin,<br>% | White<br>Blood<br>Cells | Poly-<br>mor-<br>phous<br>cells,<br>% | Lym-<br>pho-<br>cytes,<br>% | Monocytes<br>and<br>Basophils,<br>% | Blood<br>Sugar,<br>Mg.<br>per<br>100 Ce. | Blood<br>Urea,<br>Mg.<br>per<br>100 Ce. | Blood<br>Choles-<br>terol,<br>Mg.<br>per<br>100 Ce. |                          |
| G. L.                     | 57  | M   | 6/6    | 6/6   |  | 6 mo.    | Specific gravity, 1.010:<br>normal | 4,540,000             | 91                    | 6,250                   | 72                                    | 27                          | Mono., 3                            | 98                                       | 13                                      | 150   | 6'25"                    |
| J. M.                     | 41  | M   | 0/9    | 6/6   |  | 5 mo.    | Specific gravity, 1.018:<br>normal | 3,030,000             | 93                    | 11,850                  | 78                                    | 22                          | .....                               | 90                                       | 12                                      | 200   | 6'20"                    |
| D. U.                     | 23  | M   | 6/9    | 6/12  |  | 3 mo.    | Specific gravity, 1.018:<br>normal | 4,620,000             | 85                    | 7,100                   | 61                                    | 34                          | Mono., 2<br>Baso., 1                | 81                                       | ..                                      | 226   | 6'                       |

\* The bromsulphalein test and Wassermann test of the blood gave negative results for all patients.

† The light threshold obtained on the qualitative machine (an adaptometer made by the American Optical Co.) is given. By the qualitative device the normal threshold is up to five minutes. The threshold for night blindness is usually up to seven minutes, although rarely I have seen patients with night blindness with a threshold up to ten to eleven minutes.

G. L., J. M. and D. U., the 3 patients with idiopathic night blindness, showed varying degrees of pathologic dark adaptation. F. E., with simple glaucoma, who showed a greater degree of pathologic dark adaptation than D. U., was not night blind. W. C., with primary carcinoma of the liver, who had the most pathologic curve of all 5 patients,



Curves showing that the degree of pathologic dark adaptation does not bear any relation to night blindness.

No light was seen by W. C. at three minutes. This is called "absolute rod suppression."<sup>5b</sup>

The decreasing severity as evidenced by the up-turn of the curve at the eighteen minute reading of G. L. and the thirty minute reading of W. C. is often noted in dark adaptation and is called "rod suppression."<sup>5b</sup>

Slight irregularity of curve of D. U. at twelve and at eighteen minutes is due to inattention on the part of the patient: The plotting of the curve in dark adaptation lends objective qualities to a subjective test.

definitely did not have night blindness. While the degree of pathologic dark adaptation does not indicate whether the person is night blind or not, so far as night blindness itself is concerned it may be said of a person who is night blind that usually the greater the pathologic dark adaptation in this condition, the longer the condition is present and the longer the duration of cure. This is also noted when light thresholds are taken on the qualitative device (table 1).

G. L., J. M. and D. U. each suffered with night blindness of unknown origin (idiopathic night blindness). Unfortunately, only G. L. persisted in taking treatment, and his night blindness improved after three months of intensive vitamin A therapy.

*Frequency of Occurrence of Night Blindness.*—While night blindness does not constantly accompany marked pathologic dark adaptation, it is of interest to note how often diseases which were not known to be accompanied by night blindness have been found to have this condition as part of the symptom complex.

Dark adaptation study of a number of patients with hepatic diseases,<sup>8a</sup> including hepatic cirrhosis, has often shown pathologic dark adaptation<sup>9</sup> so marked as to approach that of the organic type seen in cases of retinitis pigmentosa, choroiditis and similar conditions, yet the patients were not night blind. W. C. is one of this group. Yet a few patients with cirrhosis of the liver and not so marked pathologic dark adaptation had definite night blindness. Of 15 patients with hepatic conditions who were carefully questioned, 2 claimed that they were actually night blind. Three of 22 with renal calculi gave a history of night blindness.

Some degree of night blindness is seen in a large proportion of persons. They are ordinarily not aware of their condition unless asked about it specifically. The diet of many is unbalanced either through need or indiscretion, so as to cause eventually an avitaminosis. I have seen a number of these persons when using the qualitative dark adaptometer<sup>10</sup> and have always been able to detect this lack of vitamin A by carefully going over their diet. There is a group of avitaminotic patients who consume enough vitamin A for ordinary purposes but whose absorption of vitamin A is retarded under certain conditions.<sup>11</sup>

*Precaution.*—To obviate errors in the grouping of patients with night blindness, the technician should be reminded that night blindness is not to be confused with presbyopia. Patients in the neighborhood of

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9. Their pathologic dark adaptation<sup>8a</sup> was exceeded only by that of persons with alcoholism who were examined at the psychopathic department of the Philadelphia General Hospital.

10. Feldman, J. B.: An Instrument for Qualitative Study of Dark Adaptation, *Arch. Ophth.* **18**:821 (Nov.) 1937.

11. Mathews, A. P.: *Principles of Biochemistry*, Baltimore, William Wood & Company, 1936, p. 414.

40 years of age, when asked if they see well at night, might confuse their poor reading in subdued light with night blindness. Technicians not ophthalmologically trained have been known to make this error.

*Duration and Cure of the Disease.*—The cure of either avitaminosis A or night blindness is usually of short duration, but even in cases of mild involvement it may be unduly prolonged for some unknown reason.

I have had under my care a physician, S. A., who suffered with night blindness for about one year; his diet (lack of vegetables and butter) was such as would be expected to terminate eventually in avitaminosis A. With the regulation of his diet and the inclusion of 60,000 international units of vitamin A daily, it took considerably over seven months before an improvement was noted. It is now close to two years since that time and the condition has not recurred.

As a general rule, it may be said that, as is seen in many other diseases, the longer a disease remains untreated the greater is the pathologic involvement and the longer the possible time for cure. This is shown by the three degrees of intensity of pathologic dark adaptation, D. U. being sick for three months, J. M. for five months and G. L. for six months (table 1 and the accompanying chart).

Vitamin A does not actually cure a constitutional disease. It assists the proper medication in the individual case. Thus, for example, J. F.,<sup>8a</sup> a patient suffering with hypothyroidism, had received intensive treatment. Various medications were used—thyroid extract, vitamin A and carotene separately, thyroid extract and carotene and thyroid extract and vitamin A. The purpose was to determine the relative merit of each form of therapy in this particular case.<sup>12</sup> During a period of almost eight months, twelve dark adaptation studies had been done. The patient never fully recovered, as shown by the result of the dark adaptation studies and the clinical symptoms from which he suffered, until he finally received the combination of vitamin A and maximum thyroid medication.

The same results have been experienced with cases of renal calculi<sup>5b</sup> in which pathologic dark adaptation either alone or combined with night blindness accompanied the condition.

It took some months of active treatment of the renal condition plus vitamin A therapy before the night blindness improved and the calculi ceased to form or increase in size. Needless to say at this point, no renal calculi were ever dissolved by the vitamin A therapy which was administered.

In certain cases of hepatic involvement the patient sometimes improved clinically under massive vitamin therapy, but the night blindness

12. Massive doses of carotene and vitamin A (up to 90,000 units daily) were used, but only very minimal thyroid medication.

and pathologic dark adaptation were not corrected. This may have been because the disease was too far advanced or the treatment was not continued long enough.

*Treatment.*—The vitamin requirement according to the present day literature gives 5,600 international units as the daily need of the adult.<sup>13</sup> The dose used for patients with hepatic and renal involvement was usually 30,000 to 90,000 units daily, either by injection or by mouth. No ill effects were noted from these large doses.

I have found that the addition of minute doses of compound solution of iodine, except where contraindicated, has greatly aided in the efficacy of the vitamin A. The administration of all the vitamins combined, just as in multiglandular therapy, is advised by many clinicians. The idea seems to be basically correct, since a poor diet is often accompanied by a lack of other vitamins.

#### GLAUCOMA

In 1936<sup>14</sup> I called attention to several of my patients at the Wills Hospital who had definite glaucoma and normal dark adaptation. Casten and Shaad<sup>15</sup> made a similar observation when reviewing some of the cases of glaucoma in the series of Derby and Waite, which they studied.

As has been previously noted, the marked pathologic dark adaptation observed in a study of some of the hepatic diseases approached in a great measure that found in cases of severe glaucoma (see the curve of W. C. in the chart).

With respect to hepatic function, it may be said that at present there does not appear to be a laboratory test which will furnish the clinician with a reliable index of the metabolism of the liver, owing perhaps to the great amount of hepatic reserve.

I felt, however, that it would be worth while to investigate several metabolic factors, particularly with the thought that this might possibly result in my being able to explain the normal adaptation curve of several of my patients with frank glaucoma.

For each patient with glaucoma, a urinalysis, a basal metabolic study, a complete blood count, a bromsulphalein test, a cholesterol test, a Wassermann test and an examination of the blood sugar were done. It is interesting to note that the results of the bromsulphalein test were negative. The observations on the cholesterol content of the blood of this small group of patients, however, were such as to merit mention in this paper.

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13. Eddy, W.: Progress in the Vitamin Field, *J. Am. Dietet. A.* **13**:223, 1937

14. Feldman, J. B.: Dark Adaptation as a Clinical Test: Technic and Results, *Arch. Ophth.* **15**:1004 (June) 1936.

15. Casten, V., and Shaad, D. J.: Diagnostic Value of Tests of the Light Sense in Early Glaucoma, *Arch. Ophth.* **9**:52 (Jan.) 1933.



It should be noted that the patients with glaucoma whom I examined were not known to be diabetic, arteriosclerotic or suffering with hypothyroidism.<sup>16</sup> Only 1 of these patients showed a minus basal metabolic rate, but he was otherwise symptomless.

*Cholesterol.*—This substance is a sterol, which is one of the indicators of fat metabolism. Its normal content in the blood is given variously as up to 225 mg. per hundred cubic centimeters of blood.

It is interesting to note that ergosterol (provitamin D) is another one of the type of sterols and that vitamin A, while not a sterol, is a transition form between the sterols and the aliphatic alcohols.

Apropos of this clinical investigation concerning the possible role of the liver in the pathogenesis of glaucoma, it is worthy of note that Krause<sup>17</sup> mentioned a difference in opinion in the findings of various observers as to the relation between cholesterol content and intraocular hypertension.

It will be noted that in none of the cases of night blindness mentioned in table 1 was there a truly pathologic value for blood cholesterol. These three examples are typical of my investigations of night blindness relative to the blood cholesterol.

Neither have I found the two, that is pathologic dark adaptation and a high cholesterol content, associated so often in other diseases as was noted in my small series of cases of glaucoma (table 2). To show how the two, dark adaptation and cholesterol content, varied in other conditions, 16 patients<sup>18</sup> were examined who were suffering with a variety of diseases, such as hypothyroidism, hyperthyroidism, myxedema, exogenous obesity, Frölich's syndrome, adrenal insufficiency and meningocoele. Fourteen (87.5 per cent) had normal values for blood cholesterol and 2 (12.5 per cent) had pathologic values. However, of this group 12 (75 per cent) had pathologic dark adaptation and 4 (25 per cent) had normal dark adaptation.<sup>4</sup>

In the cases of hepatic disease, which included Laënnec cirrhosis, simple jaundice, toxic hepatitis, primary carcinoma of the liver and syphilitic cirrhosis, there was the most striking disparity between the results obtained with such tests of hepatic function as the cholesterol test and those obtained with the dark adaptation test. Here the results of the dark adaptation test were more indicative of the clinical state of health of the patient than those of either the cholesterol test or some of the other tests for hepatic function.

16. These conditions are known to be accompanied by a high cholesterol content.

17. Krause, A. C.: *The Biochemistry of the Eye*, Baltimore, Johns Hopkins Press, 1934.

18. Only patients of this group whose cholesterol content was determined are considered here.

Of this group of 17 patients<sup>19</sup> examined,<sup>sa</sup> 13 (76.5 per cent) had a normal blood cholesterol content, while 4 (23.5 per cent) had a high content. Of this group, however, only 3 (18 per cent) had normal dark adaptation, while 14 (82 per cent) had pathologic dark adaptation. Indeed, in some the pathologic dark adaptation was so great as to

TABLE 2.—Data on Fourteen

| No. of Patient | Initials of Patient | Age, Yr. | Sex | Vision (Without Correction) |        | Disease and Duration                                | Visual Field* |       | Tension (Schiötz) |       | Results of Urinalysis  |
|----------------|---------------------|----------|-----|-----------------------------|--------|---|---------------|-------|-------------------|-------|--|
|                |                     |          |     | O. D.                       | O. S.  |   | O. D.         | O. S. | O. D.             | O. S. |  |
| 1              | A. A.               | 65       | F   | 6/12                        | 6/60   | Simple glaucoma 1 yr., 8 mo.                        | ++            | ×†    | 20                | 55    | Sp. gr., 1.016; alb., +1; W.B.C., 6-8; R.B.O., very occasional   |
| 2              | A. B.               | 50       | F   | 6/60                        | 6/30   | Simple glaucoma 6 mo.                               | + —           | + —   | 25                | 45    | Sp. gr., 1.018; alb., neg.; sugar, neg.                          |
| 3              | F. B.               | 69       | M   | H. M.                       | 6/12   | Simple glaucoma 2 yr.                               | ×             | + —   | 48                | 33    | Sp. gr., 1.018; alb., neg.; sugar, neg.                          |
| 4              | S. B.               | 59       | M   | 6/12                        | Blind  | Chronic congestive glaucoma 2 mo.                   | ++            | ×     | 42                | 70    | Sp. gr., 1.008; alb., neg.; sugar, neg.                          |
| 5              | W. D.               | 70       | M   | 6/9                         | 6/6    | Simple glaucoma 2 yr.                               | + —           | + —   | 28                | 26    | Sp. gr., 1.010; alb., neg.; sugar, neg.                          |
| 6              | F. E.               | 60       | F   | 6/60                        | 6/12—2 | Glaucoma 1 yr., 6 mo.                               | ++            | + —   | 20                | 28    | Sp. gr., 1.012; alb., neg.; sugar, neg.                          |
| 7              | M. H.               | 49       | F   | 6/6                         | 6/6    | Simple glaucoma 1 yr., 6 mo.                        | + —           | + —   | 20                | 20    | Sp. gr., 1.022; alb., neg.; sugar, neg.                          |
| 8              | A. McA.             | 55       | F   | 6/15                        | 6/15   | Glaucoma secondary to ulcer; keratitis 1 yr., 7 mo. | + —           | + —   | 22                | 22    | Sp. gr., 1.008; few hyaline casts; leukocytes, 15-20, high power |
| 9              | J. McK.             | 56       | F   | 6/60                        | 6/60   | Simple glaucoma 5 mo.                               | +             | +     | 22                | 90    | Sp. gr., 1.026; leukocytes, 4-6, high power                      |
| 10             | L. M.               | 68       | F   | 6/15                        | 6/12   | Simple glaucoma 3 yr.                               | +             | +     | 22                | 40    | Sp. gr., 1.025; faint trace of alb.                              |
| 11             | P. R.               | 59       | F   | L. P.                       | 6/12   | Simple glaucoma 6 mo.                               | ++            | ++    | 80                | 18    | Sp. gr., 1.002; trace of alb.; W.B.C., loaded                    |
| 12             | T. S.               | 69       | M   | 6/60                        | 6/12   | Simple glaucoma 1 mo.                               | +             | +     | 15                | 15    | Sp. gr., 1.012; alb., neg.; sugar, neg.                          |
| 13             | A. S.               | 58       | F   | L. P.                       | 6/12   | Simple glaucoma 9 mo.                               | ×             | ++    | 90                | 40    | Sp. gr., 1.014; erythrocytes                                     |
| 14             | J. Z.               | 57       | M   | 6/60                        | 6/6    | Simple glaucoma 3 yr.                               | ++            | ++    | 24                | 20    | Sp. gr., 1.018; alb., neg.; sugar, neg.                          |

\* Under "Visual Field," + — indicates slight or no deviation from the normal perimetric field.

† The pathologic involvement is indicated in the order of its intensity from + to +++. A × denotes the greatest degree of pathologic involvement wherein the visual field or dark adaptation was unobtainable.

approach the adaptation curve of organic pathologic dark adaptation obtained in cases of marked retinal disease.

Tests of hepatic function in this preliminary study of the patients with glaucoma included only the bromsulphalein test and the cholesterol test. Since none of my patients had any clinical evidence of actual hepatic disease, it was therefore not felt that such studies as the determination of the icterus index, the Takata Ara test and similar tests were

19. Only patients of this group whose cholesterol content was determined are considered here.

particularly indicated. Only 2 of the patients in my group suffered with night blindness. All had a negative Wassermann reaction. The ages varied from 49 to 69. The blood studies were done during fasting. All the other tests were done at midday and, as in the blood studies, usually on the day the dark adaptation studies were made.

*Patients with Glaucoma*

| Basal<br>Meta-<br>bolic<br>Rate,<br>% | Blood Study           |                       |                         |                                    |                             |  | Blood Chemistry                       |  |                              |  | Dark Adaptation† |            |
|---------------------------------------|-----------------------|-----------------------|-------------------------|------------------------------------|-----------------------------|--|---------------------------------------|--|------------------------------|--|------------------|------------|
|                                       | Red<br>Blood<br>Cells | Hemo-<br>globin,<br>% | White<br>Blood<br>Cells | Poly-<br>morpho-<br>nuclears,<br>% | Lym-<br>pho-<br>cytes,<br>% | Monocytes,<br>Basophils and<br>Eosinophils,<br>% | Blood<br>Sugar,<br>Mg. per<br>100 Cc. | Urea<br>Nitro-<br>gen,<br>Mg. per<br>100 Cc. | Brom-<br>sulf-<br>alin,<br>% | Blood<br>Choles-<br>terol,<br>Mg. per<br>100 Cc. | O. D.            | O. S.      |
|                                       |                       |                       |                         |                                    |                             |  |                                       |  |                              |  |                  |            |
| +31                                   | 4,980,000             | 83                    | 7,100                   | 82                                 | 7                           | Mono. 7  | 100                                   | 11   | 0                            | 350  | Pathologic<br>++ | x          |
| - 2                                   | 4,450,000             | 88                    | 7,000                   | 58                                 | 38                          | Baso. 1<br>Eosin. 2                              | 100                                   | ..   | 0                            | 175  | Normal           | Normal     |
| + 2                                   | 5,040,000             | 90                    | 5,900                   | 61                                 | 36                          | Mono. 3  | 100                                   | 14   | 0                            | 233  | +++              | Pathologic |
| + 8                                   | 3,900,000             | 80                    | 9,750                   | 54                                 | 42                          | Mono. 4  | 98                                    | 17   | 0                            | 320  | Pathologic<br>++ | x          |
| +14                                   | 4,480,000             | 83                    | 6,050                   | 65                                 | 29                          | Mono. 6  | 90                                    | 10   | 0                            | 285  | Pathologic       | Pathologic |
| - 6                                   | 4,000,000             | 75                    | 8,000                   | 60                                 | 36                          | Mono. 3<br>Baso. 1                               | 129                                   | 19   | ..                           | 230  | Pathologic       | Pathologic |
| + 6                                   | 4,550,000             | 83                    | 10,400                  | 54                                 | 46                          | .....  | 90                                    | 14   | 0                            | 150  | Pathologic       | Pathologic |
| + 4                                   | 4,500,000             | 77                    | 6,000                   | 56                                 | 32                          | Mono. 12   | 80                                    | ..   | 0                            | 220  | Pathologic       | Pathologic |
| +27                                   | 5,000,000             | 90                    | 6,050                   | 64                                 | 29                          | Mono. 5<br>Eosin. 2                              | 74                                    | ..   | ..                           | 264  | Pathologic<br>+  | x          |
| - 2                                   | 3,270,000             | 38                    | 5,650                   | 70                                 | 27                          | Mono. 2<br>Eosin. 1                              | 98                                    | 15   | 0                            | 200  | Pathologic       | Pathologic |
| + 6                                   | 4,460,000             | 80                    | 6,700                   | 60                                 | 36                          | Mono. 4  | 81                                    | 10   | 0                            | 206  | x                | Normal     |
| + 1                                   | 4,600,000             | 90                    | 7,300                   | 58                                 | 37                          | Eosin. 5   | 95                                    | 9  | ..                           | 184  | Pathologic       | Pathologic |
| - 1.5                                 | 4,000,000             | 77                    | 5,000                   | 38                                 | 62                          | .....  | 80                                    | 10   | 0                            | 236  | x                | Pathologic |
| -20                                   | 4,200,000             | 80                    | 5,350                   | 74                                 | 23                          | Mono. 1<br>Eosin. 2                              | 91                                    | ..   | 0                            | 310  | Pathologic       | Pathologic |

The few patients with normal tension and pathologic dark adaptation (table 2, nos. 1, 6 and 12) and with normal visual fields and pathologic dark adaptation (nos. 3, 5 and 8) are significant.

Patient 7, whose glaucoma was quiescent, had good vision, normal visual fields and tension of 20 in each eye at the time of my studies, yet she had pathologic dark adaptation. It may be said of this patient that while her fundus did show slight cupping, tension was noted at one time of her illness to be as high as 60 (Schiötz) in the left eye.

One patient (no. 10) had a complication of secondary anemia; another (no. 13) had lymphatic leukemia. Such complications as nephri-

tis, pyelitis and a high basal metabolic rate without clinical evidences of hyperthyroidism were noted. A number of my patients had a lymphocyte count above normal.

These incidental complications are not significant so far as glaucoma is concerned, since such conditions are often noted in other chronic diseases.

I did not find any correlation whatever between the presence and the degree of pathologic dark adaptation, ocular tension, the chronicity of the glaucoma or the cholesterol content of the blood.

What was most impressive, however, particularly on comparison of my group of cases of glaucoma with the cases of hepatic diseases, was the large percentage of high cholesterol contents in the former.

Four patients with pathologic dark adaptation had a normal cholesterol content. On the other hand, 8 patients with glaucoma had a cholesterol content higher than normal, that of 5 being abnormally so; all had pathologic dark adaptation.

Two patients with glaucoma (nos. 2 and 11) and with normal dark adaptation had a normal cholesterol content. These 2 were the only ones in my group who showed this phenomenon of true glaucoma with normal dark adaptation.

The role of cholesterol in glaucoma and its interpretation by dark adaptation will be clarified only by a continued study of a larger group of patients.

#### SUMMARY

Attention is called to the presence, but the none too frequent association, of night blindness in patients suffering with renal calculi and glandular and hepatic diseases.

Night blindness is, however, frequently encountered in association with dietary indiscretions in which there is a definite lack of vitamin A in the food. In these cases the cure is effected in a moderately reasonable period. However, even in such simple cases the treatment may sometimes be prolonged before night blindness is overcome.

The chart on which the dark adaptation study is plotted is described so that one can readily separate the cone from the rod adaptations.

Night blindness does not bear any relation to the intensity of pathologic dark adaptation. Thus, for example, many patients with hepatic disease whose dark adaptation curve almost approaches that of persons with retinitis pigmentosa do not necessarily suffer with night blindness.

Care must be exercised by the technician in questioning the patient in order to determine if the supposed night blindness from which he suffers is not presbyopia instead of night blindness.

The treatment of night blindness and avitaminosis A is discussed briefly.

The association of a high cholesterol content of the blood in the few cases of glaucoma is noted.

In view of these interesting data, it is felt that this subject should be studied further in order that an unbiased opinion may be obtained relative to association between sterol metabolism and glaucoma.

With the examination of a large number of persons with beginning uncomplicated glaucoma who have not been operated on, one may possibly be in a position to determine whether or not defective sterol metabolism plays any part in the cause or the effect of the disease.

It is possible that pathologic dark adaptation may be found of value as an indication in evaluating a phase of faulty metabolism of the liver.

A few of my patients with glaucoma were from Service A and were used for this study with the permission of Dr. Andrew Knox.

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#### DISCUSSION

DR. ROBB McDONALD: I have been interested in the problem of dark adaptation for some time and have tested a number of patients, using the adaptometer devised by Dr. Hecht. I think that many workers in testing the light sense are likely to forget the normal physiologic function of the retina. All ophthalmologists know that in the light-adapted state what is termed "visual acuity" is maximum at the fovea and decreases abruptly if one shifts his gaze from fixation. The reverse holds for the dark-adapted state; the fovea is blind, and the sensitivity of the retina to a flash of light increases just as abruptly if the test flash moves away from the fovea toward the periphery.

In my hands the light sense test is at times considerably more difficult to make and to evaluate than ordinary qualitative perimetry. This is due chiefly to the fact that one is working in the dark and cannot see the patient. Poor fixation on the patient's part may give high threshold readings. If one does obtain a high threshold reading with one test, I do not feel that one is justified in giving the patient some vitamin A concentrate and then on the second examination, if there is improvement, in stating that the patient was deficient in vitamin A. Patients improve greatly with practice with this type of examination. If one gives the patient 1 mg. of aqueous carotene intramuscularly the effect is usually rapid. I have done this during the dark adaptation test on patients with known vitamin A deficiency and have noticed an almost immediate or significant response (lowering of the threshold).

I have not tested many patients with glaucoma, but with the few I have tested, if the test flash falls on a nonscotomatous area of the retina, the final threshold has been within normal limits. Glaucoma produces typical defects of the fiber bundles in the visual field, and I feel that taking of visual fields is a much more accurate method of diagnosis and of following the course of the disease.

One must remember that dark adaptation is a physiologic process which goes on for hours. It takes at least twenty to thirty minutes to obtain threshold readings that are fairly consistent. This factor, plus the technical difficulties of working in the dark and the maintenance of fixation, add to the complexity of the test. With trained observers the test is relatively simple, but for the average hospital patient I feel that one must have well controlled observations before concluding that there is faulty dark adaptation.

# CLINICAL STUDY OF TRANSILLUMINATION OF THE EYELIDS

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After a review of the literature on transillumination of the eye, a study of the lids by the same method of lighting was undertaken to determine what information could be derived from such an examination.

## INSTRUMENT

Several instruments were tried and found to be more or less successful in showing up some of the structures of the lids by transillumination. Among these were the Lange transilluminator, the bulb of the electric ophthalmoscope, both with and without the condensing lens, the whole illuminating system of the May ophthalmoscope detached from the head and, finally, an especially designed prism transilluminator modeled after the lighting system of the ophthalmoscope.

The last-mentioned instrument is the one with which most of the observations were made. It consists of a stem with a threaded end, which fits on the handle of some ophthalmoscopes (Welch Allyn, National and perhaps others) and which takes in its other end the bulb of a National ophthalmoscope. A small condensing lens fits over the bulb; a brass cap containing a prism similar to the ophthalmoscope prism fits over the whole stem to complete the instrument. Figure 1 shows the stem in the center, the condensing lens to the right and the cap with the prism to the left. Light is projected from the prism alone, so that there is no disturbance from extraneous light. The intensity of the illumination can be controlled easily by the rheostat on the handle of the ophthalmoscope. The light from this instrument, as described, is, of course, unfiltered light. It has been found that for some observations, particularly for bringing out the canaliculus lacrimalis, that the total light is too great and that there must be a considerable reduction by the rheostat.

## TECHNIC

The method found most satisfactory for both the amount of information obtained and the ease of application for the patient and the observer follows:

1. A dark room is essential for good results.
2. It is best for the patient and the observer to remain in the dark room several minutes before examination is started, to allow for dark adaptation, partial at least.

3. The observer should stand or sit in front of the patient.
4. For transillumination of the lower lid the patient should be looking up; for the upper lid, she should be looking down.
5. The instrument should be placed on the patient's right lid with the observer's left hand, and vice versa.
6. The structures of the lid should be studied with a binocular loupe for best results.
7. To transilluminate the lower lid, the instrument is placed about 3 or 4 mm. below the margin of the lid. It should point toward the nose, and with the illuminating system on the skin the lid is then everted over the transilluminator. Placing the illuminating system in the conjunctival sac and observing the tissues through the skin was tried but found to be uncomfortable for the patient and not satisfactory from the standpoint of recognizing the structures of the lid. For the upper lid the same principle is used; i. e., the instrument is placed on the skin and the lid everted over it.

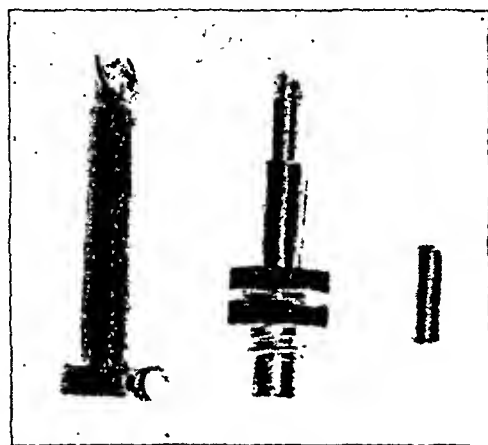


Fig. 1.—Special prism transilluminator. The portion on the right is the condensing lens; that in the center, the stem, and that on the left, the cap with the prism.

#### APPEARANCE OF THE NORMAL LID

When the light is first turned on, it appears as though the whole lid were uniformly illuminated. However, after a moment of accommodation and close observation, it is soon apparent that the light coming through the lid is interrupted by various shadow-forming substances in the tissues.

Starting from the inner canthus, one is able to distinguish several obvious differences in the light. The most striking structure that meets the eye is a bright spot near the inner canthus, surrounded by a dark halo. This spot and halo apparently represent the punctum lacrimale. Starting from the bright spot representing the opening of the canaliculus lacrimalis, one is able, by careful search and some reduction in the intensity of the light, to follow the course of the canaliculus as it goes through the lid toward the lacrimal sac. It appears as a line just slightly brighter and clearer than the surrounding tissue. One notices

that it starts perpendicular to the margin of the lid, continues for about 2 mm., broadens out slightly, makes a right angle turn toward the inner canthus, and then continues beneath the rounded fold of skin internal to the punctum lacrimale in a straight line until it disappears from sight.

One may then observe the hair follicles. It is possible with good illumination and the binocular loupe to see deeply into the pits of the follicles, following the hair down, and in some cases one can observe the bulbs on the hair roots. I have not as yet been able to observe the glands of Moll and Zeiss with any amount of accuracy.

The meibomian glands are the next structures to be studied. The openings of these glands appear as minute bright dots, pinpoint in size, all along the edge of the lid close to the conjunctival side. Occasionally one is able to see some of the sebaceous material being excreted through the openings.

On inspection of the conjunctiva, it can be seen that each of these openings connects with its own particular gland structure. Each gland has a definite pattern, which can easily be seen with the binocular loupe, and is separated from its neighboring gland by a bright line perpendicular to the margin of the lid. The pattern of each gland is made up of two small granular lines with an even smaller bright line separating them. The total width of these three lines is about 1 mm. The two darker lines occupy approximately four fifths of the space and the bright line about one fifth. The openings of the gland, on the border of the lid are an average of 1 mm. apart. The glands extend back from the margin of the lid, 3 to 5 mm. on the lower lid and much farther on the upper lid.

The fine bright line separating the two darker portions of the gland apparently represents its main duct and can be seen to connect directly with a corresponding bright dot on the edge of the lid. Most of the time the glandular lines are directly perpendicular to the margin of the lid, more so in the lower lid than in the upper. However, occasionally they take a somewhat sinuous course. In this case the small bright lines representing the ducts do not show up as clearly as when the glands are perpendicular.

The remainder of the tarsus, in fact of the lid, seems to transilluminate diffusely pink. Figure 2 shows the appearance of the transilluminated lower lid of the left eye with the prism transilluminator in place. One can see clearly in this illustration the small openings of the glands and the structure of the glands as previously described. The insert depicts the illumination of the punctum lacrimale and the canaliculus lacrimalis of the same eyelid.



## PATHOLOGIC CONDITIONS

There are several abnormal conditions of the eyelids which show definite formation as they are seen in the transilluminated lid.

In the first place, most foreign bodies which get either on the lid or in the lid are entirely opaque and hence cast a black shadow in the surrounding pink normal tissue. Concretions of the lid usually cast a dense shadow, in spite of the fact that they are not actual calcifications. They are usually seen along the course of the meibomian glands. Transillumination in the case of concretion merely gives confirmatory evidence, since in practically all instances the concretions can be easily seen with ordinary oblique illumination. Sometimes one or two that are more deeply seated than usual will appear on transillumination when they could not be seen with oblique illumination.

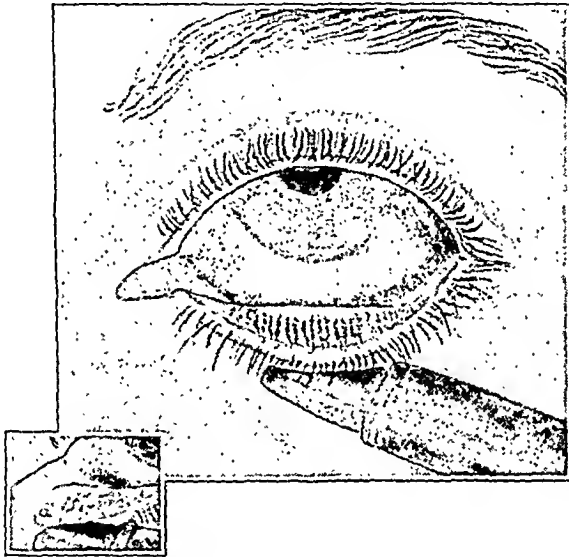


Fig. 2.—Transilluminated lower lid of the left eye, showing the meibomian glands and ducts. The insert shows the punctum lacrimale and the canaliculus lacrimalis. The prism transilluminator is in place.

A chalazion, as seen with this type of examination, presents a somewhat unexpected appearance. The gland which is involved shows as a bright area and clearer than the surrounding tissues; in other words, it gives the appearance of a small cyst. The duct of the gland involved is usually about two or three times as large as the normal meibomian duct. As yet I have not been able to find any shadow-forming obstruction which might give rise to the formation of the cystlike structure. In some cases of chalazion more than one of the glands is involved. If this is the case, one sees on transillumination two definite bright areas, each connected with a dilated duct. Occasionally a communication can be found between the two glands involved.

The acute conjunctivitides and blepharitides do not seem to show any striking picture with this test. However, in the chronic conditions, when there has been thickening of the lids, they are of velvety appearance on ordinary inspection. On transillumination the meibomian glands show various stages of dilation of the ducts.

The follicles in a case of well established trachoma transilluminate clearly, but those of vernal catarrh cause dense shadows. Hence, it can be seen that this method of examination is of definite use in the differentiation of vernal catarrh and trachoma in the well advanced stages.

When the lid is injured by laceration or abrasion, transillumination can be used to great advantage to determine the presence of foreign particles. It is often possible to determine the extent of the laceration or abrasion by the use of this lighting.

#### SUMMARY AND CONCLUSIONS

The literature on transillumination of the eye has been reviewed.

An instrument for transilluminating the eyelid is described and illustrated.

The technic of this method of examination is given in detail.

It has been shown that transillumination of the eyelid is useful (*a*) in studying the lacrimal drainage apparatus, (*b*) in studying chalazions, (*c*) in examining injuries to the eyelid, (*d*) for detection of foreign bodies of the lids and (*e*) for differentiating between well advanced vernal catarrh and trachoma.

Future studies on transillumination of the lids will consist of the following: (1) study of the anatomic structure of the canaliculus lacrimalis by means of introduction into it of (*a*) solid materials; such as a lacrimal probe, various waxes, etc., and (*b*) liquid materials, such as mild protein silver and other more or less opaque fluids; (2) transillumination of the lid by means of filtered light (this has already been tried, but without much success because the ophthalmoscope with which it was tried did not give sufficient intensity of illumination to get good detail); (3) studies of the transilluminated lid stained with the vital stains; (4) studies with polarized and fluorescent light; (5) transillumination of the lacrimal sac, and (6) further studies on pathologic conditions of the lids.

It is to be noted that the study reported here is not in any way complete. It has been included with the introduction of the instrument described merely to show that the instrument is useful and to suggest many instances in which it can be of assistance in the study of various ocular conditions.

# INDUCED SIZE EFFECT

## III. A STUDY OF THE PHENOMENON AS INFLUENCED BY HORIZONTAL DISPARITY OF THE FUSION CONTOURS

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Experiment has shown that when a difference in the sizes of the images of the two eyes is introduced either in the horizontal or in the vertical meridian (by placing a meridional size lens, with axis vertical or horizontal before one eye) all objects in the binocular field, except that at the fixation point, appear displaced in depth from their original positions. In general, the displacements are such that the whole binocular visual field appears as if it had undergone at the fixation point a certain amount of rotation about a vertical axis. This change is most apparent when the field is free from perspective clues.

A difference in the sizes of the images introduced in the horizontal meridian changes the disparities of the retinal images of all objects in the binocular visual field in the meridian of stereoscopic depth perception. Hence, in accordance with geometric optics, false stereoscopic depth impressions of all objects relative to the fixation point arise from the changed disparities. The apparent rotation that occurs with a difference in the sizes of the images in the horizontal meridian is therefore designated as a geometric effect. The magnitude of this apparent rotation of the binocular visual field can be computed from the geometric arrangement of objects relative to the two eyes and from the magnification properties of the meridional size lenses used. Experiment has verified these theoretic expectations, except under conditions where strong empiric factors, such as perspective, were present.

On the other hand, the apparent rotation that occurs because of a difference in the sizes of the images in the vertical meridian, which is designated as the induced size effect, has no obvious geometric or known functional basis. This effect constitutes a new phenomenon in binocular depth perception.

The general facts concerning these two phenomena, particularly the latter, have been recently described in two papers.<sup>1</sup> In these it was

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1. Ogle, K. N.: (a) The Induced Size Effect: I. A New Phenomenon in Binocular Vision Associated with the Relative Sizes of the Images in the Two Eyes, *Arch. Ophth.* 20:604 (Oct.) 1938; (b) II. An Experimental Study of the Phenomenon with Restricted Fusion Stimuli, *ibid.* 21:604 (April) 1939.

shown that the two effects differ in three general respects: First, if the meridional size lens is placed before one eye, the direction of the apparent rotation in the induced effect, when the magnification is vertical, is opposite to that found in the geometric effect, when the magnification is horizontal. Second, the magnitude of the apparent rotation in the geometric effect is nearly proportional to the difference in the sizes of the images in the horizontal meridian for all values; whereas the magnitude of the apparent rotation in the induced effect increases with the difference in the sizes of the images in the vertical meridian only within a definite range, at the limits of which the rotation reaches a maximum, beyond which it then decreases slowly. Thus, the graphic representations consist of a straight line in diagonal quadrants for the geometric effect and an elongated S-shaped curve in the opposite diagonal quadrants for the induced effect. The effects differ, finally, in that the magnitude of the induced effect depends on the nature and number of fusion contours in the visual field. These various results indicate that the two effects are intrinsically different.

These phenomena were measured by means of a test plane, mounted so that it could be rotated about a vertical axis. While fixating the plane, which was suitably screened, the observer would adjust it for an apparent frontal position, first in normal binocular vision and again when a given meridional size lens was placed before one eye. The difference in rotational positions of the plane in the two instances was the measure of the apparent rotation caused by the size lens.

For descriptive purposes, it is convenient to designate the ratio of the apparent rotation to a given difference in the sizes of the images as the sensitivity. This is usually expressed as degrees of rotation for a difference in size of 1 per cent. The sensitivity at a point on a curve which graphically represents a set of data will be the slope of the tangent line to the curve at that point. Thus, in the geometric effect the sensitivity is nearly constant for all ordinary differences in the sizes of the images in the horizontal meridian; whereas in the induced effect the sensitivity varies with the magnitude of the difference in the sizes of the images in the vertical meridian, being maximum in the central part of the elongated S-shaped curve. With a complex visual pattern on the test plane, as that, for example, which consists of a large number of small dots scattered irregularly over both sides of a sheet of plate glass, experiment has shown that the maximum sensitivity of the induced effect is of the same order as the sensitivity of the geometric effect. But with a simpler pattern the maximum sensitivity of the induced effect is much smaller than that of the geometric effect.<sup>1b</sup>

The induced size effect will occur, however, if only a single contour is presented above or below the fixation point. For such simple patterns, the maximum sensitivity was found to be nearly independent of the

distance of the contour from the fixation point. Other results of the experiments with simple patterns<sup>1b</sup> suggested that whatever the exact nature of the induced effect might be, its magnitude seemed roughly proportional to the particular effort to fuse the two pairs of vertically unequal disparate images. The magnitude of the effect seemed to be associated with the strength of the fusional stimuli exerted by the pattern and with the magnitude of the vertical disparities introduced into the retinal images of this pattern by the meridional size lens.

Further insight into the nature of the phenomenon can be found only in the study of experiments in which specific changes in the effect occur with definite changes in the experimental arrangement or in the particular patterns used. Such a change has been found in the experiment with an apparatus in which the test plane can be inclined to the visual plane of the observer. The sensitivity of the effect in that case is found to decrease with a decrease in the inclination of the plane. This result is believed to be due to the horizontal disparities between the retinal images of points on the plane that are introduced when the plane is inclined less than the vertical. To study the influence of horizontal disparities in their simplest form, it was necessary to devise a combination haploscope and test plane arrangement wherein the reflected images of simple patterns could be adjusted for given horizontal disparities relative to the center of the plane. The results of these studies are considered in this paper.

#### INCLINED TEST PLANE

*Apparatus and Procedure.*—The apparatus for the experiments with an inclined test plane is a modification of those used previously.<sup>1</sup> By means of suitable forehead rests and a chin cup, the observer's head is so adjusted that as he fixates an object (or test) plane his eyes are in symmetric convergence and the visual lines are horizontal (figs. 1 and 2). The object plane is so supported that it can be tipped about a horizontal axis at any desired inclination and that it can be rotated by the observer about some other axis. Two arrangements of mounting the rotation axis relative to the horizontal axis were used in these experiments. In the first case, as illustrated schematically in figure 1, the axis of rotation is vertical for all inclinations of the plane. In the second case, as illustrated schematically in figure 2, the axis of rotation lies in the plane and is inclined with the plane. In each case the inclination is specified by the angle ( $\phi$ ) between the visual plane of the observer and the test plane. When the object plane is vertical, the inclination angle is 90 degrees. Suitable scales attached to the frames indicate the inclination and the rotational position of the plane.

In these experiments the object plane itself consists of a sheet of plate glass 30 by 30 by 0.3 cm., on the surface of which various types of suitable fusion patterns are painted or attached. Beyond the plane a large sheet of uniformly illuminated white cardboard is suspended, against which these patterns are seen by the observer. A suitable shield of white cardboard is mounted before the eyes in order to restrict the binocular visual field to the object plane and thus to

eliminate the influence of most empiric factors. The pattern that was used most consisted of many small dots of india ink scattered irregularly over both surfaces of the glass. Such a pattern assures fusional stimuli for stereoscopic vision and yet has no obviously recognizable perspective configurations.

In making settings, the observer adjusts the plane so that it appears normal to his own median plane. When the object plane is inclined he is frequently instructed to imagine the dots to be marbles and to adjust the plane so that they would all tend to roll directly toward him. It is important only that the observer use consistently the same criterion for adjusting the plane in the entire series of experi-

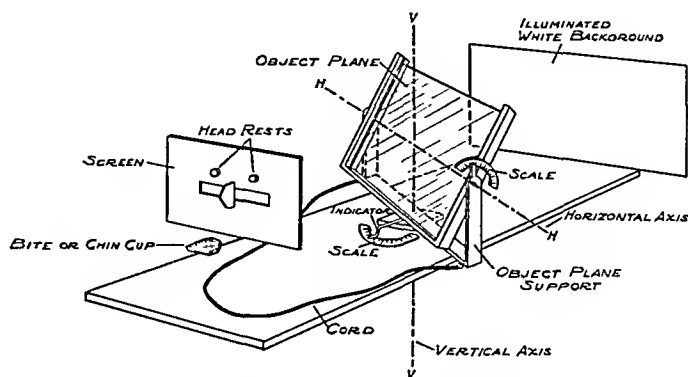


Fig. 1.—Schematic drawing of the apparatus used to study the induced size effect with an inclined test plane when the apparent rotations are measured about a vertical axis.

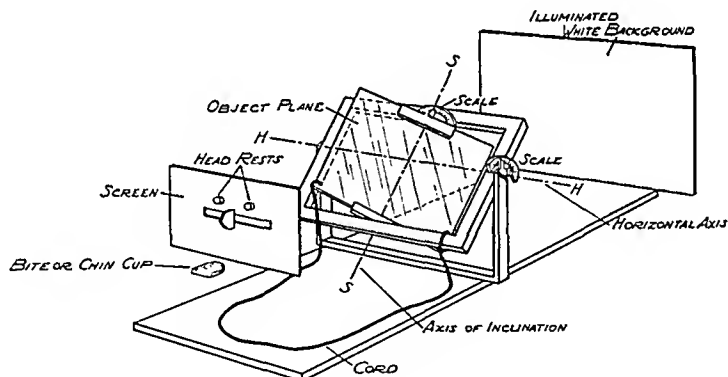


Fig. 2.—Schematic drawing of the apparatus used to study the induced size effect with an inclined test plane when the apparent rotations are measured about an inclined axis.

ments. The object plane is set and locked for each given inclination, and a number of settings are obtained for each of a series of meridional size lenses placed before one eye. In this manner the data are collected for the apparent rotations caused by a series of meridional size lenses of increasing magnification placed alternately before the two eyes.

*Experimental Results.*—There is a difference in the results of the geometric and the induced size effects for the inclined test plane, depend-

ing on whether the apparent rotations are measured about the vertical or the inclined axes. They will, therefore, be described separately. Since the primary interest in this particular study concerns the sensitivities of the effects (the amount of apparent rotation in degrees per 1 per cent of magnification), the magnifications of the meridional lenses used were limited to 4 per cent.

1. Apparent Rotation Measured About a Vertical Axis: The apparatus used is shown schematically in figure 1. First, the geometric effect for a number of inclinations of the test plane is studied by finding the apparent rotations caused by placing before one eye meridional size lenses which affect the size in the horizontal meridian only. Typical data obtained by one observer for a visual distance of 40 cm. are given

TABLE 1.—*Geometric Effect; Apparent Rotation (in Degrees) of an Inclined Plane About a Vertical Axis When a Difference in the Sizes of the Images in the Horizontal Meridian is Introduced by Size Lenses\**

| Meridional Size Lens<br>Axis 90° | Inclination Angle = $\phi$ Degrees |             |             |             |
|----------------------------------|------------------------------------|-------------|-------------|-------------|
|                                  | 90.0°                              | 55.5°       | 41.7°       | 20.0°       |
| Lens before right eye            |                                    |             |             |             |
| 4%.....                          | -14.3 (0.3)                        | -11.1 (0.3) | -12.7 (0.2) | -10.5 (0.7) |
| 2%.....                          | - 5.1 (0.2)                        | - 5.1 (0.2) | - 5.1 (0.2) | - 3.1 (0.7) |
| Normal.....                      | + 3.0 (0.4)                        | + 2.3 (0.4) | + 2.3 (0.2) | + 2.4 (0.5) |
| Lens before left eye             |                                    |             |             |             |
| 2%.....                          | + 9.8 (0.0)                        | +10.1 (0.0) | + 9.4 (0.3) | + 8.6 (0.7) |
| 4%.....                          | +18.1 (0.1)                        | +18.6 (0.1) | +13.1 (0.3) | +17.0 (0.6) |

\* The data of R. H. D. are the degrees of rotation (positive counterclockwise), with mean deviations, of the object plane from a position normal to the median plane when that plane appears normal with a given difference in the sizes of the images in the horizontal meridian. For a zero angle of inclination, the plane would coincide with the visual plane of the observer. The visual distance was 40 cm.

in table 1. Inspection of these data shows that the geometric effect measured about a vertical axis is independent of the inclination of the surface. This is, of course, the expected result from purely geometric considerations. Objects in the binocular visual field will appear displaced, in the sense of a rotation about a vertical axis,<sup>2</sup> the amount of the rotation depending on the magnitude of the difference introduced in the sizes of the images in the horizontal meridian.

Contrary to the geometric effect, when the difference in the sizes of the images is introduced in the vertical meridian only, the apparent rotation is found to decrease with a decrease in the inclination of the plane. Typical data obtained by one observer are given in table 2. The sensitivity of the effect, that is, the average rotation in degrees caused by a 1 per cent difference in size, is also given in this table. Inspection of these typical results shows that the magnitude of the induced size effect changes considerably for different inclinations of the

2. More specifically, an axis perpendicular to the visual plane of the observer.

TABLE 2.—*Induced Size Effect; Apparent Rotation of the Object Plane About a Vertical Axis for Various Inclinations When a Difference in the Sizes of the Images in the Vertical Meridian is Introduced by Size Lenses\**

| Meridional Size Lens<br>Axis 180° | Inclination of the Object Plane, $\phi$ Degrees to Visual Plane |             |             |             |             |             |             |             |
|-----------------------------------|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
|                                   | 123.5°  | 90.0°       | 74.5°       | 56.5°       | 41.7°       | 35.4°       | 30.0°       | 19.0° (?)   |
| Lens before right eye             |   |             |             |             |             |             |             |             |
| 4%.....                           | +11.5 (1.6)   | +17.8 (0.5) | +18.6 (0.2) | +16.9 (0.4) | +14.8 (0.6) | +13.6 (0.8) | +11.9 (0.1) | .....       |
| 2%.....                           | + 5.7 (0.6)   | + 9.7 (0.2) | +10.1 (0.5) | +10.0 (0.3) | + 8.1 (0.4) | + 8.7 (0.2) | + 7.8 (0.4) | + 4.4 (0.5) |
| Normal.....                       | — 0.3 (0.2)   | + 1.6 (0.5) | + 2.3 (0.3) | + 2.5 (0.4) | + 2.5 (0.4) | + 3.7 (0.2) | + 3.8 (0.5) | + 3.1 (0.7) |
| Lens before left eye              |   |             |             |             |             |             |             |             |
| 2%.....                           | — 6.8 (0.4)   | — 5.1 (0.3) | — 5.4 (0.4) | — 3.6 (0.4) | — 2.5 (0.5) | — 2.0 (0.6) | — 0.3 (0.2) | — 0.2 (0.3) |
| 4%.....                           | —11.3 (0.2)   | —13.2 (0.4) | —11.5 (0.6) | —10.9 (0.5) | — 6.3 (0.8) | — 5.2 (0.3) | — 2.2 (0.3) | .....       |
| Sensitivity                       |   |             |             |             |             |             |             |             |
| Degrees rotation for 1%           | 2.91  | 3.84        | 3.80        | 3.46        | 2.66        | 2.41        | 1.84        | 1.20        |
|                                   |   |             |             |             |             |             |             | 0.95        |

\* The data (of R. H. D.) are the degrees of rotation (positive counterclockwise), with mean deviations, of the object plane from a position normal to the median plane, when that plane appears normal with a given difference in the sizes of the images in the vertical meridian. The visual distance was 40 cm.



object plane. The magnitude of the apparent rotation for a given difference in the sizes of the images in the vertical meridian decreases as the inclination of the object plane decreases. Further discussion of these findings will be postponed until later.

2. Apparent Rotation Measured About an Inclined Axis: The apparatus used is shown schematically in figure 2. Here, the object plane is rotated about an inclined axis,  $S-S$ , which lies both in the object plane and in the median plane of the observer. The angle of inclination,  $\phi$ , is again measured from the visual plane.

With this arrangement, it was found that the geometric effect also changes with the angle of inclination. Typical data obtained by one

TABLE 3.—*Geometric Effect; Apparent Rotation of the Object Plane About an Axis Inclined  $\phi$  Degrees to the Visual Plane When a Difference in the Sizes of the Images in the Horizontal Meridian is Introduced by Size Lenses\**

| Meridional<br>Size Lens<br>Axis 90° | Inclination of the Axis $\approx \phi$ Degrees |             |             |             |            |            |            |
|-------------------------------------|--|-------------|-------------|-------------|------------|------------|------------|
|                                     | 133.3°   | 123.5°      | 90.0°       | 61.0°       | 43.6°      | 33.6°      | 30.0°      |
| Lens before R. E.                   |  |             |             |             |            |            |            |
| 4.0%.....                           | −10.9 (0.3)                                    | −13.1 (0.1) | .....       | .....       | .....      | .....      | .....      |
| 3.0%.....                           | .....  | .....       | − 9.3 (0.5) | − 8.4 (0.4) | −5.9 (0.3) | −5.9 (0.3) | −3.9 (0.3) |
| 2.0%.....                           | − 6.4 (0.1)                                    | − 7.7 (0.2) | .....       | .....       | .....      | .....      | .....      |
| 1.5%.....                           | .....  | .....       | − 3.8 (0.4) | − 2.9 (0.1) | −1.9 (0.3) | −2.0 (0.3) | −0.9 (0.0) |
| Normal.....                         | − 1.6 (0.6)                                    | − 1.2 (0.2) | + 1.0 (0.0) | + 1.6 (0.2) | +1.5 (0.1) | +0.6 (0.1) | +0.4 (0.2) |
| Lens before L. E.                   |  |             |             |             |            |            |            |
| 1.5%.....                           | .....  | .....       | + 5.4 (0.2) | + 5.1 (0.3) | +5.0 (0.1) | +3.6 (0.2) | +2.9 (0.2) |
| 2.0%.....                           | + 4.2 (0.4)                                    | + 5.3 (0.5) | .....       | .....       | .....      | .....      | .....      |
| 3.0%.....                           | .....  | .....       | +11.2 (0.3) | +10.1 (0.1) | +8.5 (0.4) | +6.8 (0.3) | +5.0 (0.1) |
| 4.0%.....                           | +10.3 (1.1)                                    | +12.7 (0.2) | .....       | .....       | .....      | .....      | .....      |
| G°/‰.....                           | − 2.62   | − 3.18      | − 3.39      | − 3.02      | −2.33      | −2.03      | −1.54      |

\* The data (of R. H. D.) are the degrees of rotation (positive counterclockwise), with mean deviations, of the object plane from a position normal to the median plane, when the plane appears normal with a given difference in the sizes of the images in the horizontal meridian. The visual distance was 40 cm. and the interpupillary distance 58 mm.

observer for various inclinations of the axis are given in table 3. These data show a decrease in apparent rotation with a decrease of the inclination of the plane.

It can be shown on the basis of geometry and the theory of the longitudinal horopter that such a decrease should occur. The apparent rotation of the object plane,  $\psi$ , about an axis inclined to the visual plane by an angle  $\phi$ , caused by increasing the image in one eye in the horizontal meridian by a magnification  $M$  is given by

$$\tan \psi = \frac{M-1}{M+1} \frac{b}{a} \sin \phi \dots \dots \dots (1)$$

in which  $b$  is the visual distance and  $a$  is one-half the interpupillary distance. This relation merely means that the apparent rotation of a plane

about an inclined axis for a given difference in the sizes of the images in the horizontal meridian is as if the equivalent rotation about an axis normal to the visual plane were projected on the inclined axis. For small differences in the sizes of the images in the horizontal meridian the rotation about an inclined axis,  $R_\phi$ , would be related to the rotation about a normal axis,  $R_o$ , by

$$R_\phi = R_o \sin \phi \dots \dots \dots (2).$$

The rate of change for small differences in size will be approximately

$$G (^\circ/\%) = -0.29 (b/a) \sin \phi \dots \dots \dots (3).$$

Thus, one would expect the geometric effect to be proportional to the sine of the angle of inclination. In figure 3 the sensitivities,<sup>3</sup>  $G$ , for the data in table 3 are illustrated graphically, being plotted against the sine of the angle of inclination. Inspection shows that the data approximate a straight line through the origin and hence can be said to follow the theory, except in absolute magnitude.<sup>4</sup>

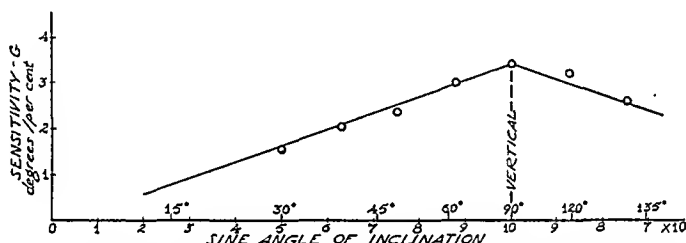


Fig. 3.—Graph showing the linear relations between the sensitivity of the geometric effect and the sine of the angle of inclination when the apparent rotations are measured about the inclined axis. These data are from table 3.

The same procedure is followed in investigating the induced size effect, when the differences in size between the retinal images are introduced in the vertical meridian. The typical data obtained by the same observer are shown in table 4, in which the values for the sensitivity,  $I$ , are also given for each inclination. These data show that the induced effect measured about an inclined axis changes even more rapidly with a decrease in the angle of inclination than when measured about the vertical axis (table 2).

The sensitivities of the induced effect from the data taken about a vertical axis (table 2) and those taken about the inclined axis (table 4) are illustrated graphically in figure 4 (and also fig. 16). The sensitivities from the latter data are corrected by dividing by the sine of the corres-

3. The average sensitivity is obtained from the slope of the straight line which best describes a given set of the data when represented graphically; see the figures and data given in a previous article.<sup>1a</sup>

4. Ogle.<sup>1a</sup> The rotational deficiency of the geometric effect.

ponding angle of inclination in order that the two sets of data will be comparable. The representation shows that the two methods yield essentially the same results.

*Induced Size Effect Resulting from Greater Magnifications (the S-Shaped Curve).*—In the experiments just described the differences in the sizes of the images in the vertical meridian used to elicit the induced effect were kept within 4 per cent. Within these limits the effect is usually proportional to the difference in size. If differences up to and greater than 10 per cent are used, this proportionality no longer holds, and the data when graphed give the typical elongated S-shaped curve.

The data of one observer, which show the influence of the inclination of the test plane on the S-shaped curve, are graphically illustrated

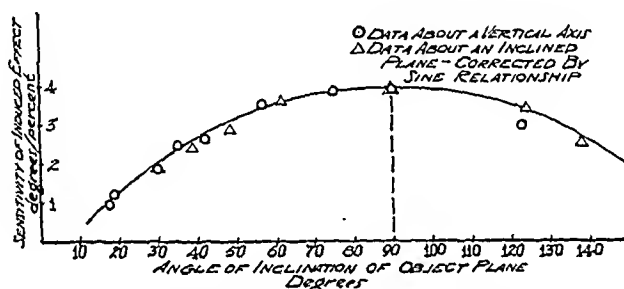


Fig. 4.—Graphic representation of the data of one observer showing the decrease of the sensitivity of the induced size effect with a decrease in the angle of inclination of the test plane. Data of R. H. D.

TABLE 4.—*Induced Size Effect; Apparent Rotation of the Object Plane About an Axis  $\phi$  Degrees to the Visual Plane When a Difference in the Sizes of the Images in the Vertical Meridian is Introduced by Size Lenses \**

| Meridional<br>Size Lens<br>Axis 180° | Inclination of Object Plane |             |             |             |            |            |            |
|--------------------------------------|-----------------------------|-------------|-------------|-------------|------------|------------|------------|
|                                      | 138.3°                      | 123.5°      | 90.0°       | 61.0°       | 48.6°      | 38.6°      | 30.0°      |
| Lens before R. E.                    |                             |             |             |             |            |            |            |
| 4.0%.....                            | + 6.4 (0.3)                 | + 8.9 (0.2) | .....       | .....       | .....      | .....      | .....      |
| 3.0%.....                            | .....                       | .....       | +12.8 (0.1) | +11.9 (0.2) | +8.0 (0.3) | +6.1 (0.3) | +3.8 (0.4) |
| 2.0%.....                            | + 3.1 (0.9)                 | + 4.4 (0.1) | .....       | .....       | .....      | .....      | .....      |
| 1.5%.....                            | .....                       | .....       | + 7.7 (0.4) | + 6.2 (0.2) | +4.4 (0.2) | +3.0 (0.3) | +2.3 (0.2) |
| Normal.....                          | — 1.6 (0.6)                 | — 1.2 (0.2) | + 1.0 (0.0) | + 1.6 (0.1) | +1.5 (0.1) | +0.6 (0.1) | +0.4 (0.2) |
| Lens before L. E.                    |                             |             |             |             |            |            |            |
| 1.5%.....                            | .....                       | .....       | — 4.5 (0.5) | — 3.0 (0.5) | —1.6 (0.2) | —1.1 (0.4) | —0.5 (0.1) |
| 2.0%.....                            | — 5.1 (0.4)                 | — 6.2 (0.7) | .....       | .....       | .....      | .....      | .....      |
| 3.0%.....                            | .....                       | .....       | —10.3 (0.3) | — 7.0 (0.4) | —4.9 (0.2) | —3.1 (0.6) | —1.9 (0.4) |
| 4.0%.....                            | — 7.7 (1.3)                 | —10.7 (0.2) | .....       | .....       | .....      | .....      | .....      |
| I°/°.....                            | 1.83                        | 2.94        | 3.90        | 3.13        | 2.11       | 1.50       | 0.95       |
| $I_v = \frac{I}{\sin \phi}$          | 2.44                        | 3.34        | 3.90        | 3.57        | 2.81       | 2.40       | 1.90       |

\* The data (of R. H. D.) are the degrees of rotation (positive counterclockwise), with mean deviations, of the object plane from a position normal to the median plane when the plane appears normal with a given difference in the sizes of the images in the vertical meridian. The visual distance was 40 cm.

in figure 5. These were obtained with the first arrangement of apparatus, in which the apparent rotation is measured about a vertical axis. The pattern on the test plane consisted of two relatively narrow horizontal bands of scattered dots, having an average distance from the center of the plane of 3.5 cm. (a visual angle of about 5 degrees for the visual distance of 40 cm.). Only four inclinations of the plane were used. The summary of the values for the maximum sensitivities, the average difference in the sizes of the images for which the maximum effect occurs and the average maximum rotation, as estimated by inspection, are given in table 5. These values show that the maximum

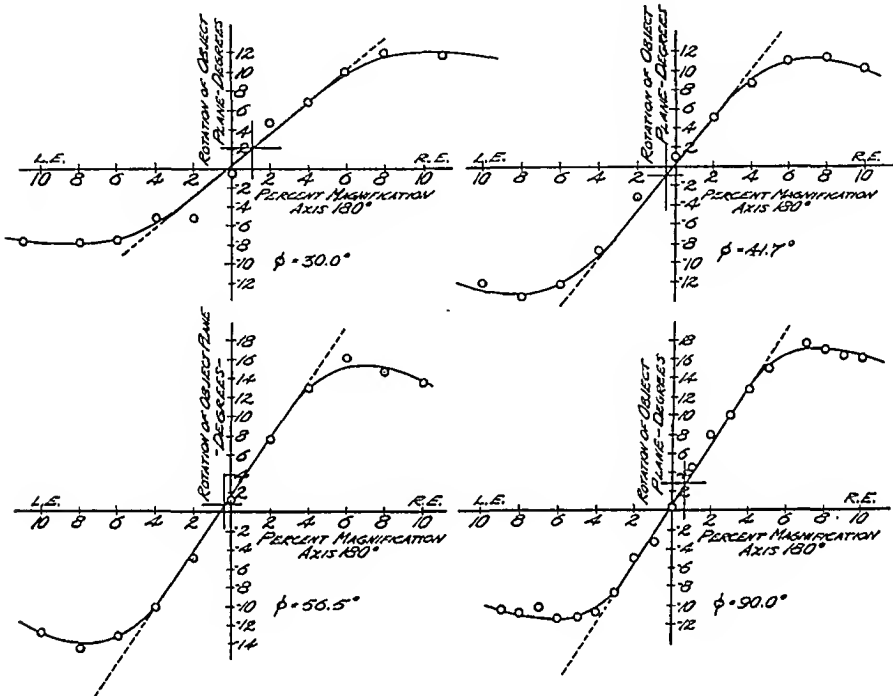


Fig. 5.—Graphic representation of data showing the S-shaped curve of the induced size effect for several inclinations of the test plane. Data of R. H. D.

TABLE 5.—Summary of the Important Characteristics of the S-Shaped Induced Size Effect Curve for the Data Obtained with Different Inclinations of the Object Plane\*

| Inclination<br>$\phi$ | Maximum<br>Sensitivity,<br>°/% | Average Maximum Differ-<br>ence on Size for the<br>Maximum Rotation, % | Average Maxi-<br>mum Rotation,<br>Degrees |
|-----------------------|--------------------------------|--|---|
| 90.0°                 | 3.8                            | 6.5  | 14.2                                      |
| 56.5°                 | 3.2                            | 7.0  | 15.0                                      |
| 41.7°                 | 2.4                            | 10.8   | 12.5                                      |
| 30.0°                 | 1.8                            | 12.0   | 10.6                                      |

\* The apparent rotations were about a vertical axis for a fusion pattern consisting of two horizontal bands of scattered dots. The visual distance was 40 cm. The data were obtained by R. H. D.

sensitivity and the maximum rotation decrease, while the average difference in sizes of the images for which the maximum effect occurs increases as the inclination of the plane becomes less. These results are consistent with the previous study<sup>1b</sup> of the phenomenon.

*Comment.*—When a surface observed binocularly is inclined from the frontal plane position, the shapes of the two retinal images change in the sense of a shear, the direction of the shear being opposite in the two eyes. A schematic representation of such projected images of a gridlike design is illustrated in figure 6. In the true frontal position vertical lines will be imaged as vertical lines on the two retinas, but in the inclined position (in the sense that the top of the surface is moved away from the observer) the retinal images of those lines will be rotated relative to their positions when the plane is vertical. Such a behavior would be expected, because the retinal images of points on the lines become increasingly horizontally disparate as the surface is less inclined,

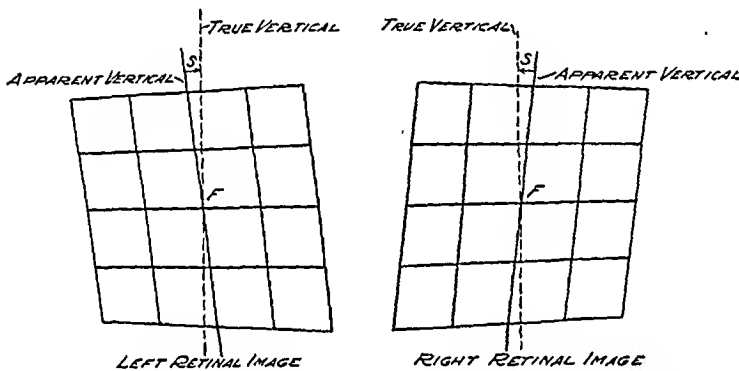


Fig. 6.—Schematic shapes of the projected retinal images of a grid pattern on an inclined plane, showing the declinations of the apparent verticals.

those points above the fixation center being uncrossed and those below the fixation center being crossed. All other points on the surface, save those actually lying in the visual plane, also become increasingly disparate as the inclination of the plane becomes less.

The true, or absolute, disparities of the retinal images of any given point on the surface will, of course, depend on the declination of the vertical meridians of the two eyes. The fact that the maximum sensitivity of the induced size effect for some persons does not necessarily occur when the inclination of the object plane is 90 degrees, i. e., vertical, may be indicative of initial declinations of the eyes.

The decrease in the induced size effect can be accounted for only by the horizontal disparities of the retinal images of points resulting from the decrease in the inclination of the test plane. For such a complex pattern this influence of many disparities of the retinal images

must be a complex phenomenon. On the assumption that the decrease in the magnitude of the induced size effect found with the lesser inclination is due to the introduction of disparities in the retinal images of points on that surface, it is important to investigate the effect with more simple patterns under controlled conditions. These experiments are described in the subsequent pages.

#### HAPLOSCOPE EXPERIMENTS—HORIZONTAL DISPARITY OF SIMPLE FUSION PATTERNS

*Apparatus and Procedure.*—The apparatus for these experiments is, of necessity, more complicated than that used for demonstrating the effect in the previous studies. The apparatus consists of a haploscope used jointly with a test plane in which the latter can be rotated about a vertical axis through the plane's center. The arrangement is shown diagrammatically in figure 7. The haploscope con-

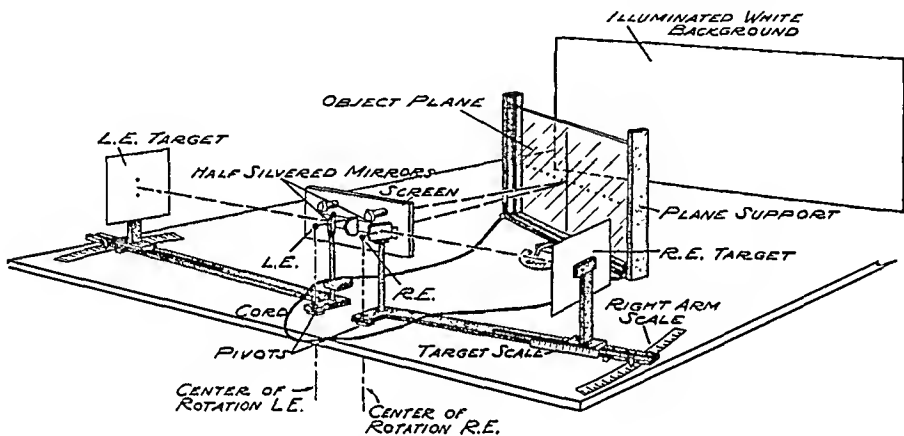


Fig. 7.—Schematic perspective drawing of the combined haploscope and rotating test plane apparatus used to study changes in the induced size effect when horizontal disparities are introduced in the fusion patterns.

sists of two arms which, when adjusted to the head of an observer, can turn about vertical axes through the entrance pupils of the two eyes. On these two arms half-silvered mirrors are so mounted before the eyes that suitable patterns on targets farther out on the arms can be seen by reflection, appearing as though they were a single pattern in front of the observer. An object plane at a visual distance of 40 cm. in front of the instrument is seen through the half-silvered mirrors. When the instrument is in adjustment for zero horizontal disparity, the binocular image of the patterns on the two targets is seen to coincide with the object plane in space. The plane can be rotated about a vertical axis and the movements controlled by the observer.

The pattern on the plane consists of a horizontal row of irregularly spaced small dots through the center of the plane: By means of these dots the rotational position of the plane can be observed. The horizontal row of dots is seen against a uniformly illuminated background. It has been found that a horizontal white

thread on which narrow, black, irregularly spaced rings have been drawn serves as well as the row of dots on the glass plate. A vertical line or thread, drawn on the plane so as to coincide with the axis of rotation, assists in holding the convergence of the eyes. The rotational position of the plane measured from the frontal position is indicated by a suitable scale.

Selected on the basis of previous experiments,<sup>1b</sup> three types of haploscope target patterns were used (fig. 8). The first consists of two identical black disks, 8 mm. in diameter, drawn on white cardboard 3.5 cm. above and below the center of the target; the second, of two vertical black wedge-pointed strips, which are also spaced equally from the center of the targets, and the third, of five horizontal white disks (4 cm. apart) on a black background the same distance above and below the center of the target. In the latter case the contrast scheme has been reversed, and a black background is suspended beyond the test dots. In each case the pattern subtended a vertical visual angle of about 5 degrees from the

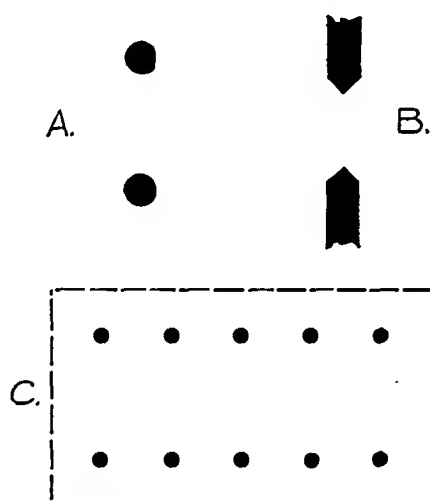


Fig. 8.—Three types of haploscope fusion patterns used in the experiments.

row of dots. Identical patterns, obtained photographically, were used on each target of the haploscope. When each target consists of any one of these types of patterns and their haploscopic images are superimposed on the object plane, the arrangement is essentially that used in preceding experiments.<sup>1b</sup>

With this adjustment of the apparatus, when a meridional size lens is placed before one eye to increase the vertical size of the image, the expected induced effect takes place; that is, there is an apparent rotation of the test plane.<sup>5</sup> The observer adjusts the horizontal row of dots for an apparent frontal position without and with the artificially introduced difference in the sizes of the images in the vertical meridian. The magnitude of the induced effect can thereby be determined from the differences in the actual rotational positions. With a series of meridional size lenses of increasing magnifications and the measurement of the accompanying

5. Again it must be emphasized that the response to the induced effect for such simple contour patterns may vary with the observer. It is greatest in those having experience in such work.





the average difference in the sizes of the images for which the maximum effects occur.

The maximum sensitivity is of greatest importance, for it is the measure of the greatest response of the eyes to differences in the sizes

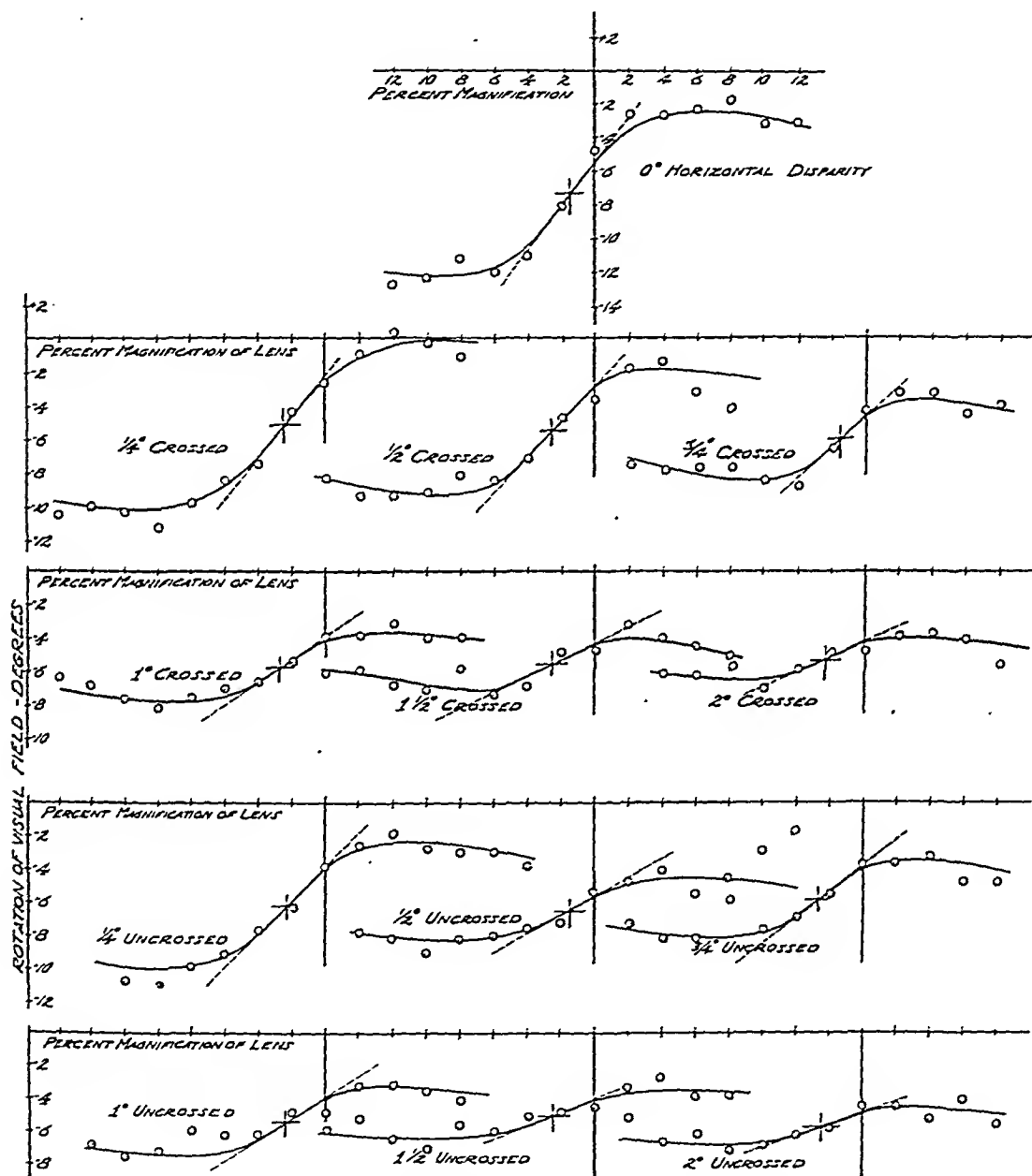


Fig. 10.—Graphic representation of typical data showing the induced effect curve for a series of different horizontal disparities of the fusion contours. Data of K. N. O.

of the images in the vertical meridian. The sensitivities for the foregoing data are illustrated graphically in figure 11, in which this sensitivity is plotted on the ordinate axis and the total angular horizontal disparity (instrumental) is plotted on the abscissa axis. A characteristic

sharp, bell-shaped figure results, which indicates the magnitude of the rather rapid decrease in the maximum sensitivity of the effect with an increase in the horizontal disparity. The sensitivities obtained from the data of a second observer are illustrated in figure 12. On the basis of considerable data, it is believed that this curve is symmetric in shape; that is, the decrease in the sensitivity is the same for the same magnitude of image disparity whether crossed or uncrossed.

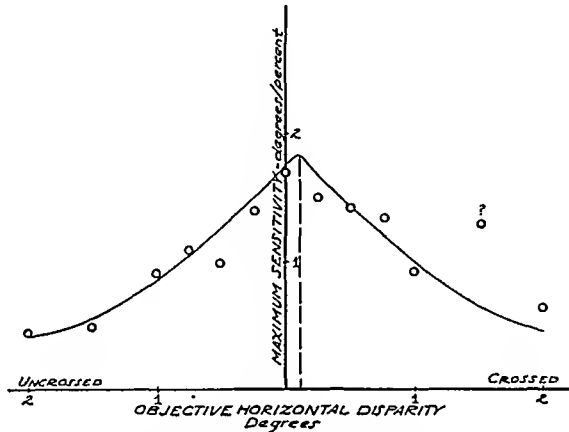


Fig. 11.—Graphic representation of the maximum sensitivities of the induced effect derived from the data of figure 10 for different horizontal disparities of the fusion patterns. Data of K. N. O.

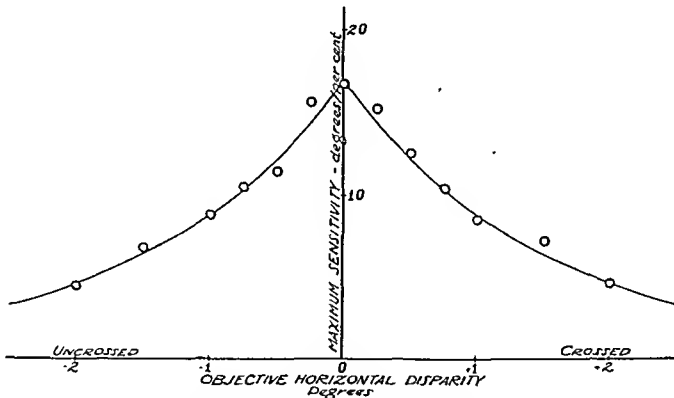


Fig. 12.—Graphic representation of the maximum sensitivities of the induced size effect for different horizontal disparities of the fusion patterns. Data of G. S. N.

It is important to note in these data that the greatest maximum sensitivity is obtained not when the targets in the instrument are adjusted for zero horizontal disparity but when they are adjusted for a specific small crossed disparity of about 0.1 degree. This fact can be taken to indicate that the zero instrumental disparity deviates 0.1

degree from the zero horizontal retinal disparity. The occurrence of this displacement is in agreement with other facts known about the ocular condition of the particular observer; namely, that he is esophoric at this visual distance and has an eso-fixation disparity and that his nonius (or true) longitudinal horopter curve lies a small distance inside the fixation point.<sup>6</sup> This situation would indicate that the maximum sensitivity, that is, the maximum response of the effect, occurs when the images of the pattern contours lie nearest to horizontally corresponding retinal points.<sup>7</sup> Additional data of other observers will be presented later.

*Comment.*—In the experiments just described the retinal images of the separated contours in the visual field were confined to particular peripheral regions of the two eyes. The introduction of a given percentage of difference in the sizes of the images in the vertical meridian causes particular vertical disparities in respect to those images. The induced effect in this case, therefore, must arise from the influence of these particular vertical disparities. The ocular response to these vertical disparities can be measured by the maximum sensitivity, that is, the degrees of apparent rotation of the binocular visual field corresponding to a 1 per cent difference in the sizes of the images in the vertical meridian at the center of symmetry of the so-called elongated S-shaped curve. It is important, then, to determine more exactly the nature of the decrease in the ocular response to these images when definite horizontal disparities have been introduced between them. It was believed that a quantitative study of the phenomenon can be made from the data obtained from the three or four observers. An analysis is presented as follows:

From a study of the curves from various sets of data, the bell shape of the usual curve obtained for the decrease of the maximum sensitivity of the effect with horizontal disparities suggested that the phenomenon might be described by an inverse exponential function of the type

$$I = I_0 e^{-c|\Delta_0|} \dots \dots \dots (4)$$

in which  $I$  is the ocular response of the induced effect, that is, the maximum sensitivity;  $\Delta_0$ , the true angular horizontal disparity of the images;  $I_0$ , the greatest sensitivity found when  $\Delta_0 = 0$ , and  $c$ , a constant.

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6. Ames, A., Jr.; Ogle, K. N., and Gliddon, G. H.: Corresponding Retinal Points, the Horopter and Size and Shape of Ocular Images, *J. Optic. Soc. America* **22**:575, 1932. Ogle, K. N.: Analytical Treatment of the Longitudinal Horopter: Its Measurement and Application to Related Phenomena, Especially to Relative Size and Shape of Ocular Images, *ibid.* **22**:665, 1932.

7. This result is comparable to that found with the inclined test plane, in which the maximum sensitivity for one observer occurred when the plane was somewhat less inclined than the vertical. These two findings suggest a means for determining points on the total horopter surface.

The disparity  $\Delta_0$  will be taken positive or negative, according to whether the horizontal disparity is crossed or uncrossed. In the relation, however, it appears as the absolute value for the purpose of obtaining a symmetric curve of the first power. For the instrumental, or objective, disparity,  $\Delta_0 = (\Delta - s)$ , in which  $\Delta$  is the instrumental disparity and  $s$  is the angular displacement of the vertical axis of symmetry of the curve from the instrumental zero disparity. It is that disparity for which the greatest maximum sensitivity occurs. To investigate the adequacy of this relation to describe the results, it is only necessary to plot the

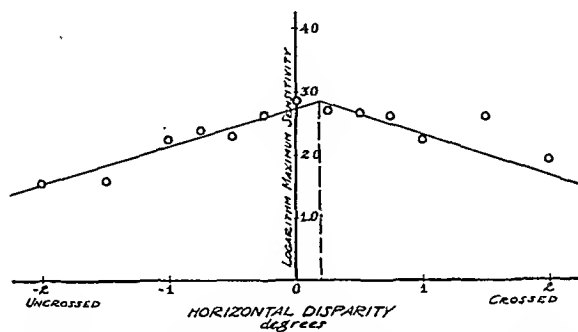


Fig. 13.—Graph showing the linear relation between the logarithm of the maximum sensitivity of the induced size effect and the angular horizontal disparity of the fusion contours. Data of K. N. O.

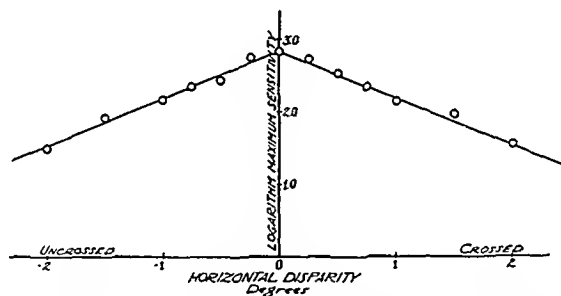


Fig. 14.—Graph showing the linear relation between the logarithm of the maximum sensitivity of the induced size effect and the angular horizontal disparity of the fusion contours. Data of G. S. N.

natural logarithm of the maximum sensitivity against the angular horizontal disparity, since

$$\log I = \log I_0 - c|\Delta - s| \dots\dots\dots (5)$$

is a linear equation.

In figures 13, 14 and 15 the maximum sensitivities derived from the data of three observers are plotted according to this method. The logarithm of the sensitivities are plotted on the ordinates and the horizontal disparities on the abscissas. In general, it appears that the values do follow a linear relation. Figures 11 and 13 illustrate the same set of data as do figures 12 and 14. The curves drawn through the points

in figures 11 and 12 were determined from the constants  $I_0$  and  $c$  obtained from figures 13 and 14. The displacement of the maximum point from the instrumental zero disparity (in figs. 11 and 13) is indicated more forcibly by this method of analysis.

On the assumption that the exponential relation describes the decrease of the induced effect with the increase in the horizontal disparity of the images, it is believed that it should be applicable in some manner to the results obtained from the inclined surface experiments described in the first section of this paper. Now the declination or angular deviation of the images of lines on a surface inclined to the visual plane from images of the same lines when the surface is vertical is given by

$$\tan \delta = \sin \epsilon \cot \phi \dots \dots \dots (6)$$

in which  $\delta$  is the angular deviation of the images in each eye;  $\epsilon$  the convergence angle of the eyes (assuming this to be symmetric), and  $\phi$ , as before, the inclination angle of the plane.<sup>8</sup> For any given contour on

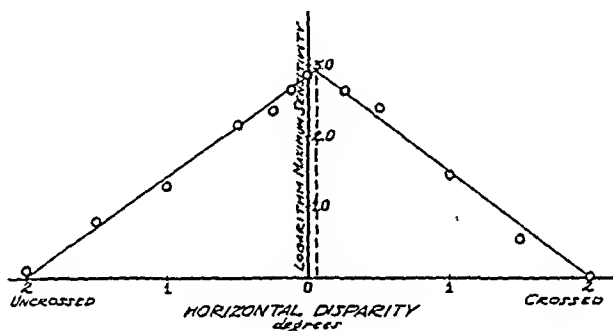


Fig. 15.—Graph showing the linear relation between the logarithm of the maximum sensitivity of the induced effect and the angular horizontal disparity of the fusion contours. Data of R. H. D.

the test surface in the median plane of the observer at a specific vertical visual angle,  $\beta$ , the total angular horizontal disparity would be, with sufficient accuracy,

$$\tan \Delta = \Delta = 2 \sin \epsilon \tan \beta \cot \phi \dots \dots \dots (7).$$

It would be anticipated, therefore, that on the average the decrease in the maximum sensitivity of the induced effect with a decrease in the inclination of the surface would be

$$I = I_0 e^{-k \cot \phi} \dots \dots \dots (8).$$

To test this relation, the sensitivities of the inclined plane data are plotted according to

$$\log I = \log I_0 - k \cot \phi \dots \dots \dots (9),$$

which again is a linear equation.

8. Helmholtz, H.: Helmholtz's Treatise on Physiological Optics, translated from the 3rd German edition, edited by J. P. C. Southall, Ithaca, The Optical Society of America, 1924, vol. 3, p. 349.

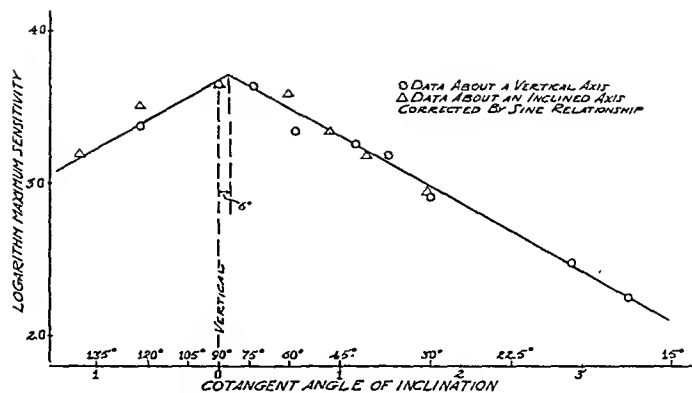


Fig. 16.—Graph showing that the logarithm of the maximum sensitivity of the induced size effect as measured about a vertical axis bears a linear relation to the cotangent of the angle of inclination of the object plane. The data are from tables 2 and 4. The values for the latter measurements about an inclined axis are corrected to those about a vertical axis according to the sine relation. Data of R. H. D.

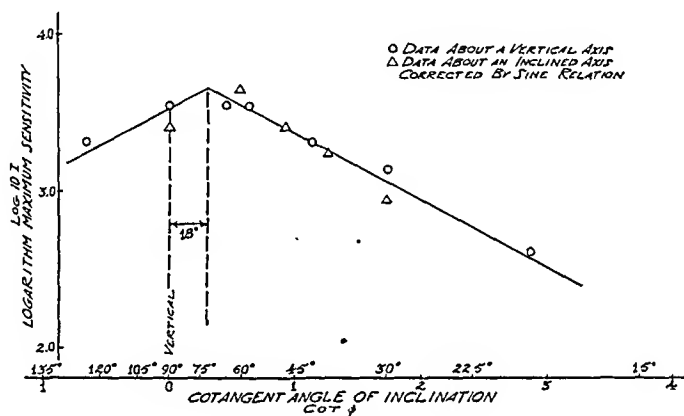


Fig. 17.—Graph showing that the logarithm of the maximum sensitivity of the induced effect as measured about a vertical axis bears a linear relation to the cotangent of the angle of inclination of the object plane. The values for the data taken about an inclined axis are corrected to those about a vertical axis according to the sine relation. Data of K. N. O.

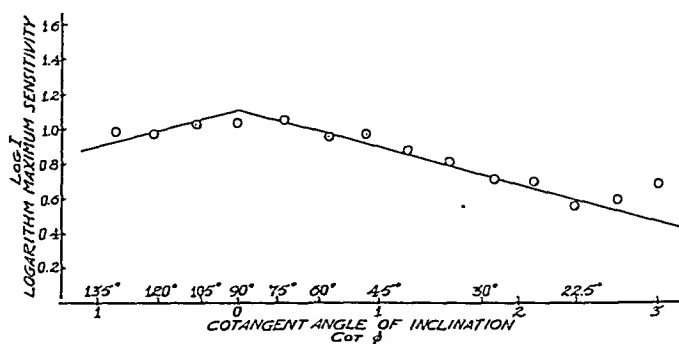


Fig. 18.—Graph illustrating that the logarithm of the maximum sensitivity of the induced size effect as measured about a vertical axis bears a linear relation to the cotangent of the angle of inclination of the object plane. Data of G. S. N.

In figures 16, 17 and 18 the data for the induced effect with the inclined surface for three observers are represented graphically according to this relation. Figures 4 and 16 illustrate the same data. Again, a study of these curves indicates that the data are adequately described by the relation.<sup>9</sup>

These graphs show more strikingly that for some observers the greatest maximum sensitivity does not necessarily occur when the surface is normal, that is, when  $\phi = 90$  degrees, but rather at some other inclination. While at times there may be a variation of 5 degrees in this displacement for the same observer, the foregoing graphs are typical. Such a displacement, as suggested before, is in conformity with a fundamental disclination (that is, an outward deviation of the tops of the corresponding vertical meridians) which exists normally for a near visual distance. This assumes, of course, that the greatest effect takes

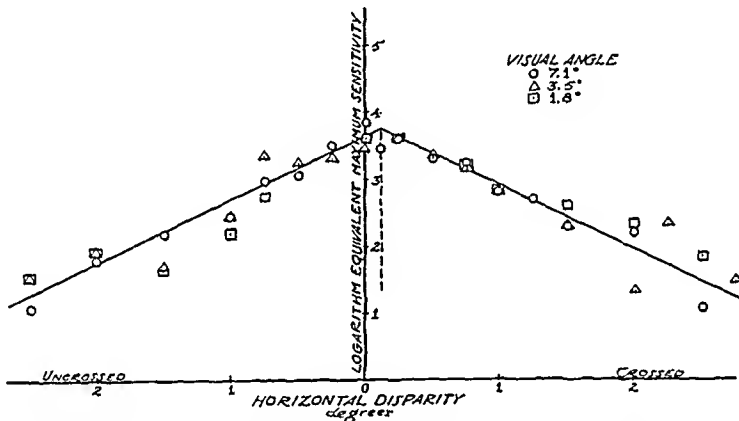


Fig. 19.—Graph showing that the decrease in the maximum sensitivity of the induced effect with horizontal disparity of the simple fusion contours is independent of the vertical visual angle subtended by those contours. Data of K. N. O.

place when the images in the two eyes fall nearest to corresponding retinal points.

However, since the data for the induced effect with the inclined surface were obtained with a pattern consisting of a large number of scattered dots, there must have been many different horizontal disparities of the retinal images from points over the whole surface. The question then arises as to whether the magnitude of the decrease in the induced effect with a horizontal disparity is less when the fusible vertical contours are nearer the fixation point or whether the decrease found with the inclined surface is the complex result of a composite or integrated innervation. To study this question, targets B and C (fig. 8) were used in the haploscope arrangement at three different separations corresponding to visual angles of 1.8, 3.5 and 7.1 degrees.

9. Roughly, it can be shown also that the maximum sensitivity is therefore approximately proportional to the sine of the angle of inclination.

Data were taken by two observers. The typical results for one observer are shown in figure 19. Because of the long and laborious procedure involved in obtaining complete data, only several points for each disparity were determined near the center of symmetry of the S-shaped curve. A study of the data indicates that a change in the distance of the fusible contours from the fixation point has no effect. One must assume, then, that unless other unknown factors are present, the decrease of the effect with the decreased inclination of the surfaces must be the result of an integration process.

From a review of all the various findings with different types of fusion patterns, disparities, etc., it appears that the magnitude of the induced effect in any particular experiment is of a specific amount, which depends on the total innervations arising from the pattern of contours as seen binocularly; that is, the effect is a positive and specific response to vertical disparities in a complex association of the separate retinal images of the fusion contours.

If one assumes that the data can be described adequately by relation 4, viz.,

$$I/I_0 = e^{-c|\Delta_0|}$$

an interpretation of the influence of horizontal image disparity of fusion contours can be made. Such a relation implies that each additional increment in the horizontal disparity of the retinal images reduces that response for the effect by an equal fraction of the response. It is as though a field of attraction exists between the horizontally disparate images, the strength of which decreases according to an absorption-like law<sup>10</sup> for increases in the separation of those images.

#### SUMMARY

Experiments were carried out to investigate the nature of the induced size effect, that is, the apparent rotation of the binocular visual field caused by differences in the sizes of the images in the vertical meridian when horizontal disparities were introduced between the images of the fusion patterns. The experiments were taken with an inclined test plane and with a combination of haploscope and rotatable test plane. In the first case, the inclination introduced horizontal disparity of the images automatically, whereas with the second apparatus specific horizontal disparities of simple fusion patterns on the haploscope targets were introduced deliberately. The results showed:

The apparent rotation of a surface about an axis inclined to the visual plane is the component of the apparent rotation that occurs about an axis perpendicular to the visual plane. That is,

$$R_\phi = R_0 \sin \phi$$

in which  $R_\phi$  is the rotation about an axis inclined  $\phi$  degrees to the

10. The relation 4 is of the same form as Lambert's law of absorption.



visual plane and  $R_0$  is the rotation about an axis normal to the visual plane.

The induced size effect decreases with the decrease in the angle of inclination of the surface.

The greatest induced effect may occur at an inclination slightly less than normal. It is suggested that this is due to basic declinations of the eyes for the given visual distance; that the greatest effect occurs when the disparities introduced by the inclined surface are in coincidence with those declinations. This, in turn, suggests that the greatest effect occurs when the surface is nearest the horopter surface.

The induced effect decreases rapidly with the horizontal disparity introduced on simple fusion contours. It was shown that the relation  $I = I_0 e^{-c|\Delta|}$  adequately described this decrease, in which  $I$  and  $I_0$  are the sensitivities of the effect at a disparity  $\Delta$  and at zero disparity, respectively. It was shown that this relation was also consistent with the inclined surface.

Again, the greatest effect occurs for a horizontal disparity that agrees roughly with the fixation disparity of the observer for the visual distance at which the data are taken. This suggests that the greatest effect occurs when the retinal images of fusion contours are nearest corresponding retinal elements.

Again attention is drawn to the accuracy with which the eyes respond to these binocular phenomena, as is evident from the small mean variations of the settings of the rotational positions of the test plane.

On the evidence presented in this paper the following conclusions can be drawn:

The phenomenon of induced size effect decreases rapidly when horizontal disparities are introduced between the images of the fusion contours. This decrease follows the same general course whether these disparities are introduced simply, as in the haploscope experiments, or complexly, as in inclined test surface experiments.

The greatest response of the eyes to the induced effect occurs when the retinal images of the fusion contours fall nearest to corresponding retinal points; that is, when the fusion contours lie nearest the horopter surface.

The decrease in the sensitivity of the induced effect with horizontal disparity seems to follow a relation of the form

$$I = I_0 e^{-c|\Delta|}$$

This suggests that the attraction or the influence between horizontally disparate images decreases fractionally with the increase of the horizontal disparity.

# ATTACHMENT TO THE FERREE-RAND PERIMETER FOR DETERMINING LIGHT AND COLOR MINIMA

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For the sake of perspective, brief consideration will be given to methods of measuring light and color sensitivity. Three methods have been used: (1) the light and color minima and light and color differences; (2) the limits of sensitivity (the perimetric method) and (3) the light minimum for the discrimination of detail.

## METHODS OF MEASURING LIGHT AND COLOR SENSITIVITY

1. *The Light and Color Minima and Light and Color Differences.*—These methods are customarily used to measure light and color sensitivity in central vision. They have not been used for practical work in peripheral vision because of the lack of a suitable and feasible means of presenting at all points in the field of vision a stimulus the intensity of which can be varied. The results obtained may be expressed in various ways. With the use of spectrum light in scientific work we have been accustomed to make the specification in radiometric or energy units (watts or ergs). With the use of white light and colored light obtained from filters and pigment surfaces this is not feasible because of the difficulty of excluding the invisible radiations. The specification has been made in photometric terms, e. g., brightness of test surface (millilamberts, etc.), illumination of test surface (foot candles, meter candles, etc.) and amount of light entering the eye (lumens per total area or unit area of test surface).

2. *The Limits of Sensitivity (the Perimetric Method).*—With this method, the one customarily used to study sensitivity in peripheral vision, the points farthest from the center of the field at which a given stimulus is visible are determined. With the minimum, or threshold, method, on the other hand, the intensity at which a given stimulus is visible at a given point in the visual field is determined. The latter method is the

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From the Research Laboratory of Physiological Optics.

older and without doubt the logical procedure; the former may be regarded as an indirect and substitute procedure, in many respects a poor one.

Among the shortcomings of the method of limits, the following faults may be noted:

(a) Comparatively few points of the retina can be tested, and the location of these points is determined by the visibility of the stimuli used. As the method is used at present, the only means available for producing changes in the limits of sensitivity are changes in the size of the stimulus and in its color and brightness relation to the background.<sup>1</sup> With neither of these means is it feasible or conveniently possible to make a wide survey of the sensitivity of the retina. In using the method of limits the examiner has therefore to be content with a meager knowledge of the functional condition of the retina. Too often he is not able to test sensitivity where the test is most needed. Indeed, handicapped as we have been by having only the method of limits at our disposal, we do not even know with certainty what are the most important points at which the test should be made for detecting different pathologic conditions and for differentiating between them. Even a brief consideration of the structural and functional differences from center to periphery of the retina in the various meridians and of the variety of disturbances that may occur will disclose the gross inadequacy of the method of limits as the sole test procedure and the great advantage of adding to it the method of minima when more detailed knowledge is needed. It is not difficult to understand that little knowledge can be obtained of the sensitivity of the retina by mapping the field with stimuli of one, two or three sizes, particularly in case of the form field—little more, so to speak, than could be had of the details of a large country by traveling along its coast line or passing around its boundaries.

(b) Even with the improvements that have been made in perimetry, the method of limits is at best a rough means for detecting loss of sensitivity and one that varies a great deal in its delicacy for this purpose in different parts of the retina. This is due to the amount of difference there is in sensitivity at points separated as little as 1 degree in the field of vision. We select 1 degree here because changes in the limits of less than 1 degree are not ordinarily detected. The delicacy of the method, therefore, can be judged by the loss of sensitivity that is

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1. Ferree, C. E., and Rand, G.: Factors Which Influence the Color Sensitivity of the Peripheral Retina, *Tr. Am. Ophth. Soc.* **18**:171-197, 1920; Effect of Size of Stimulus on Size and Shape of Color Fields, *Am. J. Ophth.* **10**:399-411 (June) 1927; Effect of Relation to Background on the Size and Shape of the Form Field for Stimuli of Different Sizes, *ibid.* **14**:1018-1029 (Oct.) 1931.

required to change the limits by 1 degree. This varies greatly, for example, from center to periphery, being in general comparatively small in the paracentral portion, larger in the midregion and very large toward the far periphery. It is great indeed around the blindspot and ordinarily extremely large around the borders of scotomas. A great loss in sensitivity would have to be experienced around the blindspot, for example, to displace its margin as much as 1 degree. In other words, just where great delicacy and high sensitivity of method are needed in the study of pathologic conditions, the method of limits is the most deficient. There is no limit, however, to the sensitivity of the method of minima other than is imposed by the means which are used to produce the changes of the intensity of the stimulus. There is no limit at all when the intensity of the stimulus can be changed in continuous series.

*Differences in the Intensity of the Stimulus Which Give Limits at Points Separated by 1 Degree from Center to Periphery of the Visual Field*

| Red (670 millimicrons)                                  |  | Green (522 millimicrons)                                |  | Blue (468 millimicrons)                                 |  |
|---|--|---|--|---|--|
| Region Examined, 180 Degree Temporal Meridian (Degrees) | Change in Color Minimum per Degree (Watt $\times 10^{-12}$ ) | Region Examined, 180 Degree Temporal Meridian (Degrees) | Change in Color Minimum per Degree (Watt $\times 10^{-12}$ ) | Region Examined, 180 Degree Temporal Meridian (Degrees) | Change in Color Minimum per Degree (Watt $\times 10^{-12}$ ) |
| 5-10  | 1.4  | 5-10  | 0.4  | 5-10  | 1.1  |
| 20-25   | 4.1  | 20-25   | 3.3  | 30-35   | 2.0  |
| 30-35   | 20.6   | 35-40   | 4.0  | 50-55   | 8.1  |
| 60-65   | 69.9   | 45-50   | 15.0   | 75-76   | 90.7   |
| 65-70   | 127.4  | 50-51   | 370.0  | 76-77   | 725.4  |
| 80-82   | 323.8  | 59-61   | 715.0  | 78-80   | 2135.9   |
| 85-87   | 2630.4   | 63-65   | 4720.0   | 83-85   | 2700.1   |
| 87-88   | 5425.2   |   |  | 87-88   | 3465.8   |

For the purpose of showing the variation in the intensity of stimulus that is required to change the limits of sensitivity by 1 degree in different parts of the field of vision, the accompanying table has been prepared. In this table the change in the minimum per degree of the visual field is shown for three spectrum colors—red (670 millimicrons), green (522 millimicrons) and blue (468 millimicrons). These data are taken from a previously published study<sup>2</sup> of color minima carefully determined at near lying points from center to periphery in two meridians, specified in terms of watts  $\times 10^{-12}$  entering the eye. At any of these points it will be remembered that the functional condition of the retina can be tested by the method of minima within the limits of delicacy of a just noticeable change of sensation.

2. Ferree, C. E., and Rand, G.: Chromatic Thresholds of Sensation from Center to Periphery of the Retina and Their Bearing on Color Theory: Part I, *Psychol. Rev.* 26:16-41 (Jan.) 1919.

(c) The method of limits has in general from the beginning been characterized by inaccuracy and variability of result, a fault so serious as formerly to have rendered the method practically worthless. Studies of factors and the development of improved methods, controls and instruments have done much in the way of correction in later times, and the study of the visual field by this method has now become standard practice. But the method is too often not successful in practical work because accuracy of result can be secured only by an amount of care greater than many examiners are willing to give. A point in question is the determination of the limit with a moving stimulus. Acceptable accuracy of result cannot possibly be obtained in this way. A good control of fixation cannot be had with a moving stimulus, and without a good control of fixation accuracy in the determination of the limit is not possible. Further, accuracy in the determination cannot be had without a proper control of the brightness of the preexposure, particularly in case of the color limits. A moving stimulus may be used to make a rough determination of the limit, but the final determination should be made with a stationary stimulus and proper precautions as to fixation, preexposure and exposure. With the method of minima, on the other hand, the exact point at which the result is to be obtained is known in advance, and the determinations, therefore, can and naturally are made with the proper conditions of preexposure and exposure and with proper control of fixation. It is clear that inaccuracy and variability of result are inherent in the method of limits and can be avoided only by an amount of care and caution that many examiners are not willing to give.

Perhaps the most serious fault of the method of limits, as it is now used, is the examiner's inability to make the test where he wishes. Occasions demonstrating the need of full freedom in this respect are: during the early stages of detachment of the retina; during the course of reattachment; for all disturbances in the central, paracentral and midperipheral portions of the retina; during the early stages of disturbances in all parts of the retina and during the advance or recession of such disturbances. The complete adequacy of the threshold method for all these conditions and the serious inadequacy of the method of limits should be clear to all.

Recognizing the usefulness and need of both methods, we have devised an attachment to the Ferree-Rand perimeter<sup>3</sup> by means of which both light and color minima can be easily and conveniently determined at any point in the field and the method of limits extended to include the use of stimuli of different intensities in a continuously graded series.

3. Ferree, C. E., and Rand, G.: An Illuminated Perimeter with Campimeter Features, *Am. J. Ophth.* 5:455-465 (June) 1922.

3. *The Light Minimum for the Discrimination of Detail.*—Sensitivity to light may be measured directly or in terms of its relation to the seeing of objects; that is, either the light minimum or the minimum amount of light required to discriminate detail in objects may be determined. Both procedures have significant and practical value. However, if light sensitivity is measured directly, its relation to the seeing of objects cannot be quantitatively inferred; nor can the effect of differences in light sensitivity in different persons or at different ages, of change in light sensitivity due to adaptation or of disturbances due to pathologic conditions on the power to see objects be correctly inferred from determinations of the light minimum. The special usefulness of the direct measurement of these effects in the testing of fitness for various kinds of work and types of ocular performance is obvious. So far as we know, the method has not been sufficiently used in the study of diseases of the eyes to show whether it has any great differential or diagnostic significance. However, apart from this it is our belief that it should be included in every important program for the study of the characteristics of ocular diseases. When it is of advantage to do so, this method can also be used for the study of sensitivity to colored light and light tinged with color or light having a dominant hue.

For the application of this method, the projector devised by us and manufactured by Bausch and Lomb Optical Company is admirably adapted. A description of this projector and a discussion of its use in determining the light minimum for the discrimination of detail were presented in an article in the *ARCHIVES* on testing fitness for night flying.<sup>4</sup> The work done with the instrument in relation to night flying at the School of Aviation Medicine, Randolph Field, may also be of interest.<sup>5</sup>

#### AN ATTACHMENT TO THE FERREE-RAND PERIMETER FOR DETERMINING LIGHT AND COLOR MINIMA

The attachment is in the form of a lamp house so constructed that it can be easily substituted for the lamp and housing originally supplied with the perimeter. The purpose of the attachment is to provide a means of varying the intensity of illumination on the perimeter arc in continuous change from zero to full without altering the color or composition of the light or the size, shape or position of the illuminated area. The essential features of the attachment are a source of light of adequate intensity to give the range needed, a housing of suitable size and shape, a mechanical means or specially designed shutter for varying the intensity of light, a

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4. Ferree, S. E., and Rand, G.: Testing Fitness for Night Flying: Visual Acuity, *Arch. Ophth.* 20:58-79 (July) 1938.

5. Allman, T. L., and Jenkins, P. H.: A Test for Night Visual Efficiency, *Flight Surgeon Topics* 2:40-46 (Jan.) 1938. Hargreaves, J. M.: A Test for L. E.: Report on Test for Night Visual Efficiency, *ibid.* 2:90-93 (April) 1938. Nocturnal Visual Efficiency, *ibid.* 2:74-75 (April) 1938. Platt, R. J., and Griffis,

diffusing plate or other diffusing means both to eliminate completely the shadows that would otherwise be produced by the shutter and to give an evenly distributed and well diffused illumination of the test object and its surroundings and a filter to correct the artificial light to daylight quality.

A photograph of the attachment in position on the perimeter is shown in figure 1. At the right of the photograph is given an enlarged drawing of the attachment, side section elevation.

The shutter consists of four vanes which extend across the opening of the lamphouse in such relation to each other that when their flat surfaces are parallel to the beam of light the maximum amount of light passes through the opening,

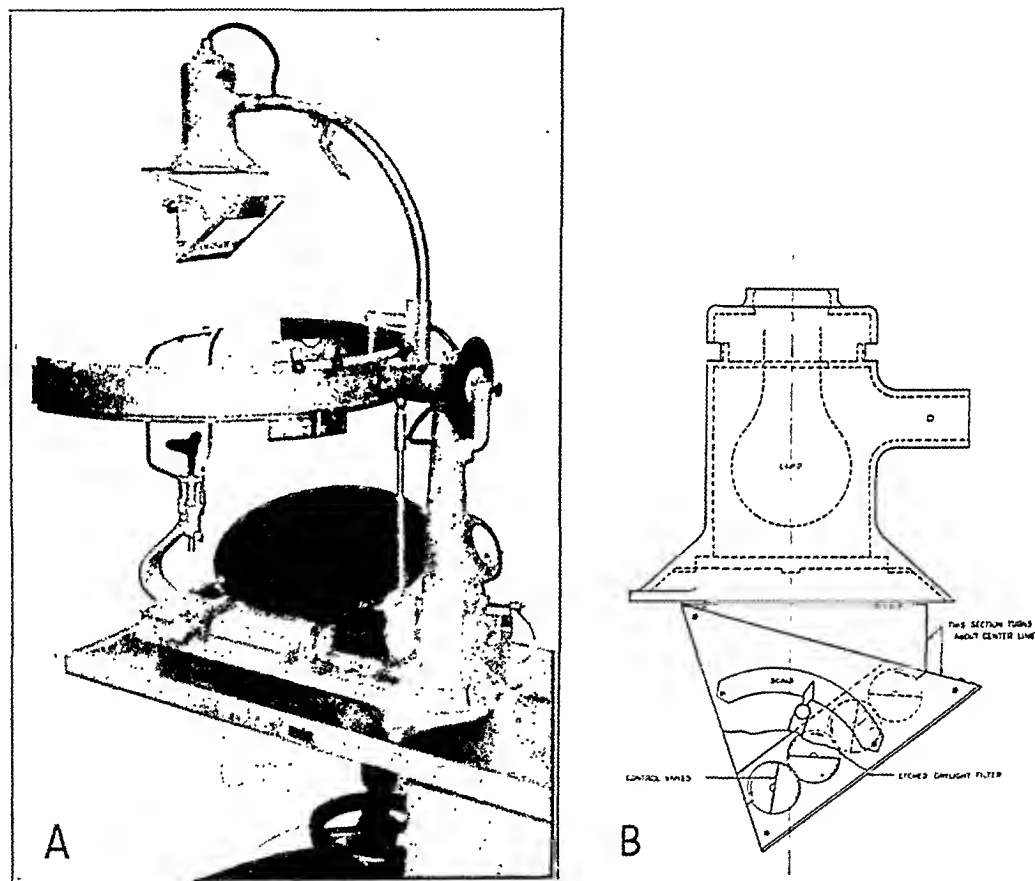


Fig. 1.—*A*, Ferree-Rand perimeter with its attachment for determining light and color minima in any part of the visual field. *B*, enlarged drawing of attachment; side section elevation.

and when they are rotated to a position at right angles to the beam the light changes in continuous series from full intensity to zero. The shutter is so actuated as to cause the contiguous vanes to turn in opposite directions. This insures that the variation of intensity is not accompanied by a shift in the position of the illuminated area or of change in its size and shape as would be the case if the vanes all moved in the same direction. The vanes are painted flat black.

In various models of the shutter different means of actuating the vanes have been employed. In the model shown in figure 1, a shaft is fastened to each vane along its longitudinal axis, and one end of the shaft passes to the outside of the housing. Mounted at the outer end of each of these shafts are small cogwheels

or gears which mesh with each other. Cogwheels are turned by means of a small knob on the end of a pointer or indicator attached directly to the shaft of one of the vanes. When the cogwheels are turned through 90 degrees, the vanes pass from the position of full light to complete extinction and the pointer passes over a graduated scale which indicates the illumination of the test object in foot candles. For the convenience of the operator in working on either side of the instrument, duplicate scales and pointers are provided on each side of the lamphouse. In order to eliminate slack or backlash in the gears and to provide an adjustment for wear, two gears are used at the end of each shaft, the purpose being that one shall be advanced just enough from the position of the other that all slack or looseness in the system shall be eliminated. To provide for this adjustment a short arc-shaped slot is cut near the edge of each outer gear through which a setscrew passes to the inner gear. In making the adjustment, the setscrew is loosened, the position of the outer gear advanced and the setscrew tightened. When positioned so that all looseness or slack in the transmission is eliminated, the setting of the vanes in any desired position can be made with great accuracy and precision.

For a later model, a simpler means was devised which is located within the housing and also is entirely free from slack or backlash. This is in the form of a thin plate with a central longitudinal slot through which pass the axle pins at the end of the vanes. Above and below it in alternate sequence are short vertical slots which engage pins suitably positioned at the ends of the vanes. The indicator which passes over the scale is attached to the end of the axle of one of the vanes. When this indicator is moved along the scale, the contiguous vanes rotate in opposite directions as is desired.

As mounted on the lamp arm of the perimeter, the attachment remains in fixed relation to the perimeter arc at all positions of rotation of the arc. However, unlike the original device, it illuminates uniformly an arc of only 70 degrees, the breadth of the tangent screen; therefore, the housing is provided with a swivel mount so that it can be turned on its vertical axis in order to illuminate the test object through the required 180 degrees of arc.

With this attachment the light and color minima can be quickly and easily determined at any point in the visual field. Also the field and the blindspot can be mapped for light and color at different levels of illumination. The latter feature greatly increases the number of points in the field that can be tested by the method of limits, giving a much greater range and versatility in this respect than are given by variation in the size of the stimulus and its relation to the background. The attachment is inexpensive to make and easy and convenient to operate.

#### SOME PRELIMINARY RESULTS

As already indicated, the attachment described can be used either for the determination of the light and color minima or as an auxiliary equipment to give different levels of illumination in the use of the method of limits for the study of the visual field. For convenience the latter will be discussed first.

1. As auxiliary equipment in the use of the method of limits the following points are some that may be noted:

(a) The form and color fields may be mapped at different levels of illumination. This is of value in two ways. In the first place it



provides a means of testing the functional condition of the retina at as many points from center to periphery as may be desired. This is possible because the controls provide for changing the illumination in continuous series; thus intensities of illumination can be found which will cause the limits of sensitivity to change by as large or as small amounts as may be wanted. In using the method of limits in this way evidence as to pathologic disturbance may be found roughly in an inspection of the relation between the limits obtained for the intensities used or more accurately by a comparison of the results with predetermined norms or critical values for the limits for whatever intensities are selected for the purpose. In this connection it may be noted, however, that the method of limits does not provide as sensitive a means for

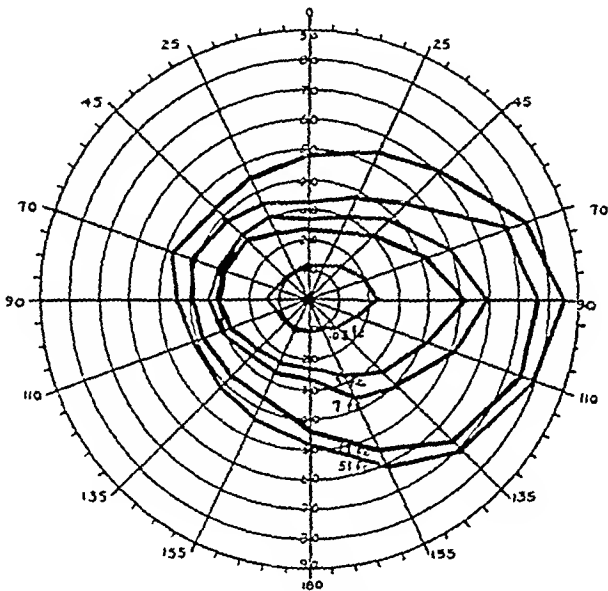


Fig. 2.—Field map demonstrating results obtained with the method of limits for testing the functional condition of the retina at different points from center to periphery. The map shows the limits for a 1 degree blue stimulus (Hering pigment paper) under an illumination of 51, 17, 7, 3 and 0.03 foot candles. In each case the background and preexposure chosen were of the same brightness as the stimulus as seen at the limit of sensitivity.

testing the functional condition of the retina as the light and color minima, for, as already shown, in some parts of the retina it requires great losses of sensitivity to produce a change of 1 degree in the location of the limit. Figure 2 is a field map showing the limits for blue (Hering pigment paper) obtained at different intensities of illumination. The range of change of intensity is greater than that provided with the attachment described, but the results serve to show the possibilities of testing the functional condition of the retina at different points by varying the intensity of the illumination.

In the second place, a knowledge of the breadth of field under different intensities of illumination has considerable value in relation to vocational fitness. For example, a test of the breadth of the field at one intensity alone is an inadequate check of the fitness of an aviator even for day flying and has little value as a test of his special fitness for flying at night or under low illumination.

(b) The functional condition of the retina may be tested at different points in any given meridian, in any segment of that meridian or in any part of the retina. As contrasted with the minima, the method in this case is to set the illumination at a given value and find the point in the field which is the limit of sensitivity for the stimulus used instead of selecting a point in the field and finding the least amount of light that will render the stimulus visible at that point. Since the illumination can be changed in continuous series, a means is thus provided for determining as many limits in a given meridian or in a given sequence as may be wanted. In using the method of limits in this way, the results could be expressed in the form of a curve in which degree of eccentricity in the field would be plotted against intensity of illumination. In this case diagnosis would be made either by an inspection of the shape of the curve or by a comparison with previously determined norms or critical values. Again attention should be called to the fact that the method of limits is, for the reasons given in (a), not nearly so sensitive nor, without an enormous amount of work, so comprehensive as the method of minima for detecting changes in the functional condition of the retina, particularly in those portions of the retina for which a test method having a high degree of delicacy is needed, namely, where the gradient of sensitivity is steep, as, for example, in the extreme periphery of the field, around the blindspot and ordinarily around scotomas.

(c) The intensity control provides an additional means of adding sensitivity to the use of the method of limits for detecting disturbances which may cause a general contraction of the field, sector or regional cuts in the field, enlargement of the blindspot or scotomas. Even with the addition of this means, however, the method of limits has much less sensitivity than the method of minima.

2. For the direct determination of the light and color minima at any point in the central and peripheral fields, the attachment affords for the first time in a clinic instrument the most comprehensive and sensitive means known to workers in physiologic optics for testing the functional condition of the retina; that is, the test can be made not only at every point in the field but within the limits of delicacy of a just noticeable change in sensation.

With the use of the attachment the determinations may be made at isolated points or in any sequence of points that best serves the purpose of the examination. For example, they may be made at successive points from center to periphery in any meridian or they may be limited to any part or segment of the meridian or to any sequence of points that will test the part or area of the retina that needs to be examined, such as the area immediately surrounding the blindspot, sector or regional cuts in the field, the region occupied by a scotoma or zones or regions in which it is known that pathologic disturbances are likely to occur. For all these purposes the examination can be made with as much or as little detail as may be desired and with a delicacy that cannot be equaled

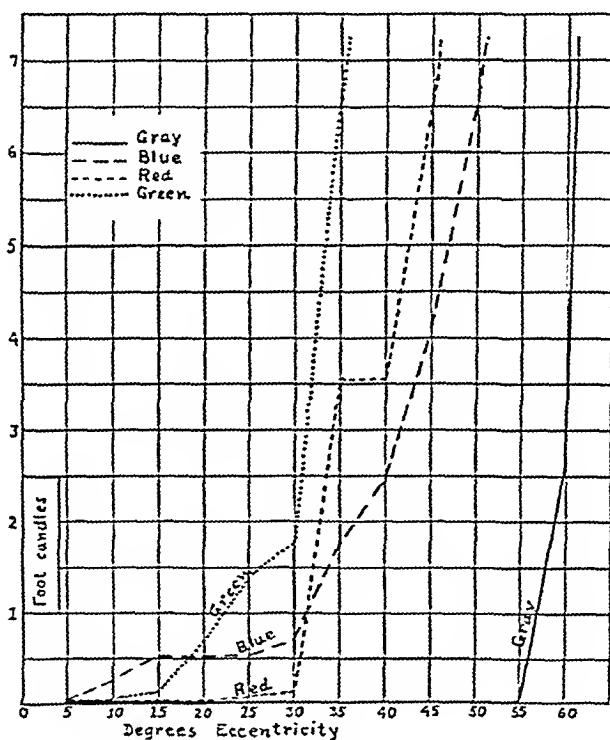


Fig. 3.—Minima for red, green, blue and gray from center to periphery of the field of vision for one representative normal subject. The stimuli were 1 degree Heidelberg pigment papers. The degree of eccentricity plotted was against foot candles of illumination.

by any other procedure. The extent and profundity of all local disturbances may be determined by a comparison of the results at the different points in the sequence.

In order to present some preliminary results obtained with the attachment in the determination of light and color minima, figures 3 to 6 have been prepared.<sup>6</sup> The curves shown in these figures afford

6. The data used in the preparation of these figures were obtained under our direction by E. F. Lewis and D. A. Franklin.

some idea of the sensitivity gradient for the light and color sense from center to periphery and the deviations from this gradient which may occur as the result of pathologic disturbance. The curves were determined in the upper temporal 30 degree meridian of the visual field. This meridian was selected because of its importance in testing for certain pathologic disturbances.

The determinations were made in a darkened room. During the period of preparation the intensity of light on the perimeter arm was set at a low value (approximately 0.001 foot candle) and the subject allowed to adapt to this illumination. This procedure provided for

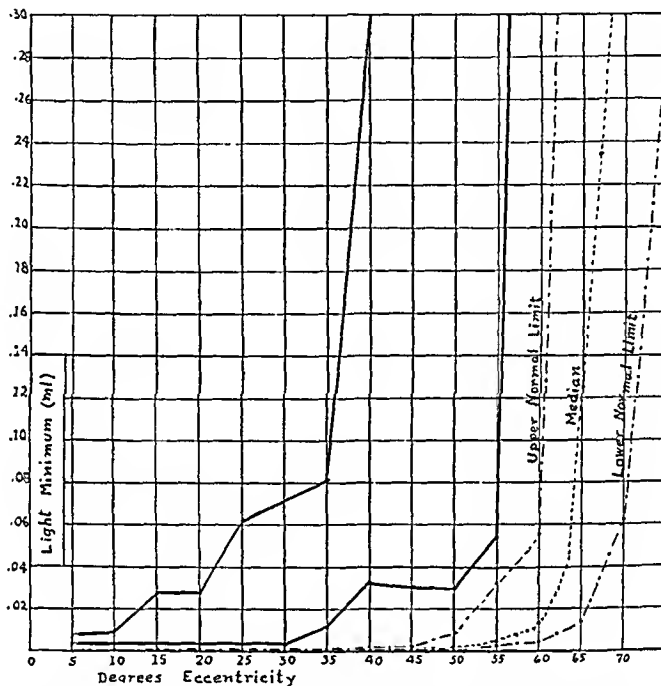


Fig. 4.—Light minimum from center to periphery of the field of vision. Curves in the 30 degree upper temporal meridian for the limiting and median values of a group of "nonpathologic" subjects (broken lines) and for 2 patients with pathologic conditions (solid lines). This meridian was selected because of its significance for diagnosis. The stimulus used was 1 degree gray (reflection factor 8.5 per cent) on black (reflection factor 4 per cent). The degree of eccentricity was plotted against millilamberts. Curves of this type are of particular value in a systematic study of the characteristics of diseases of the eyes. When determined in a sufficient number of meridians, they show what parts of the retina should be tested.

the standardization of the sensitivity of the retina in sufficient amount for the purpose and at the same time avoided the inconvenience of at any time working in complete darkness. In making each determina-

tion, the stimulus was moved to the appropriate position on the perimetric arc, the subject took his fixation and the light was quickly increased until an approximate value of the minimum was obtained. The value was then more accurately determined by using the method of preexposure; that is, the stimulus was covered with the preexposure card, the intensity of the light was quickly readjusted and the stimulus was exposed at the new intensity for 1 second, the procedure being repeated until the exact amount of light was determined at which the stimulus was just seen. A practiced examiner operating the intensity control with one hand and manipulating the preexposure card with the

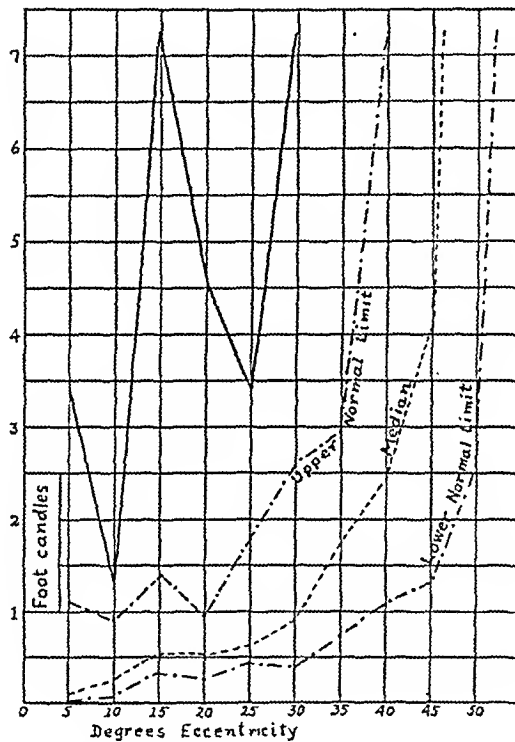


Fig. 5.—Minimum for blue from center to periphery of the field of vision. Curves in the 30 degree upper temporal meridian for the limiting and median values of a group of "nonpathologic" subjects (broken lines) and for a patient with glaucoma in the early stage (solid line). The stimulus was 1 degree blue Heidelberg pigment paper on gray (reflection factor 9.6 per cent). The degree of eccentricity was plotted against foot candles of illumination.

other can make these determinations easily and quickly—much more easily and quickly than might be supposed.

The brightness of the preexposure and surrounding field were the same as we have recommended and used in perimetric examinations; that is, for the colored stimulus it was the same as that of the colors and for the colorless stimulus it was black. The reasons for making this choice of preexposure and surrounding field have been fully dis-

cussed in previous papers.<sup>7</sup> Both the colored and the colorless stimuli subtended a visual angle of 1 degree. This is regarded by us as in general the best size to use. When a still higher degree of sensitivity is desired, a smaller stimulus may be employed.

For the colorless stimulus, a gray (reflection factor 8.5 per cent) was chosen. For this choice the following reasons may be offered: (a) If a white stimulus were used, the determinations would all be made at much lower intensities of illumination. Work at these lower intensities would be inconvenient, particularly clinic work; such intensities also would cause the determinations for the light minimum to be made at a state of adaptation unduly different from that for the color

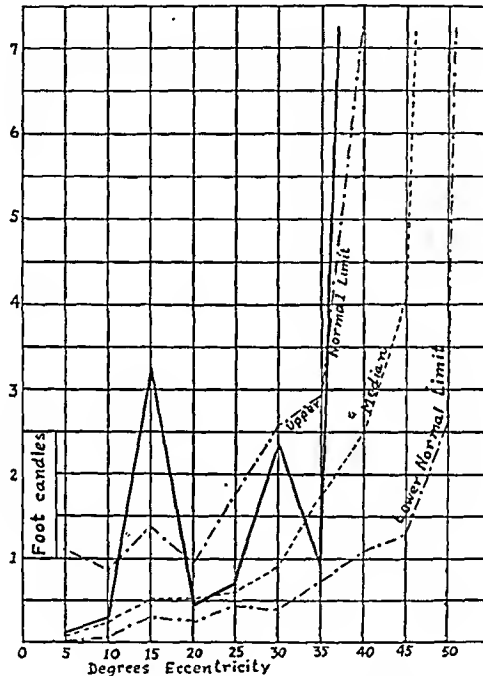


Fig. 6.—Minimum for blue from center to periphery of the field of vision. Curves in the 30 degree upper temporal meridian for the limiting and median values of a group of "nonpathologic" subjects (broken lines) and for a patient whose condition had not yet been diagnosed as pathologic (solid line). The stimulus used was 1 degree blue Heidelberg pigment paper on gray (reflection factor 9.6 per cent). The degree of eccentricity was plotted against foot candles of illumination. This figure has been prepared to show the irregularities that may be found in the minima in some cases in which a diagnosis of pathologic disturbance has not yet been made.

7. Rand, G.: The Factors Which Influence the Sensitivity of the Retina to Color: A Quantitative Study and Methods of Standardizing, Psychological Monograph 62, Princeton, N. J., Psychological Review Company, 1913, vol. 15, pp. 1-166. Ferree, C. E., and Rand, G.: Effect of Brightness of Preexposure and

(Footnote continued on next page)

minima. With the use of the gray stimulus chosen, the determinations of the light and color minima are made at more nearly the same levels of adaptation, as nearly the same perhaps as it is possible to provide, considering the way in which the determinations are made. (b) The gray stimulus requires a greater change in the amount of light to render it just visible from point to point in the visual field than a white stimulus. Therefore, the use of the gray stimulus gives the method of minima greater delicacy for picking up differences in sensitivity at different points in the field as measured by the amounts of light required to make the stimulus visible at these points. In other words, the use of the gray stimulus amplifies or magnifies the measuring scale. (c) The use of the gray stimulus does not require such fine changes in the setting of the intensity control. The use of a white stimulus, for example, would require such small changes in the setting of the control as to introduce undue and unnecessary difficulty both in the construction of the attachment and in its operation. A control which would produce such fine changes as would be required for a white stimulus and at the same time cover a range from 0 to 7 foot candles would be intricate in construction and infeasible for clinical work. The use of the gray stimulus, on the other hand, renders the simple device we have described amply adequate on all these points—range of intensity covered, delicacy or sensitivity in making the determination and ease of operation.

In figure 3 are given curves showing the minima for red, green and blue (Heidelberg pigment papers) and the gray stimulus previously mentioned. These results are for a single "nonpathologic" subject chosen as being as nearly representative as any we have ever examined. The minima are expressed in terms of foot candles falling on the pigment stimuli used. These results are given, it will be remembered, as illustrating those that may be obtained with the attachment to the Ferree-Rand perimeter which we have described and are intended only to be regarded as representative of conditions which are feasible for clinical work. In previous papers have been given results obtained by us showing the sensitivity gradient from center to periphery in two meridians<sup>2</sup> and obtained under our direction in eight meridians<sup>8</sup> for red, green, blue and yellow. In both cases spectrum colors, filtered to give still greater purity, were used and the minima measured in energy units. Such results may be regarded as representative of the best type of scientific conditions of work and as having absolute value.

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Surrounding Field on Breadth and Shape of the Color Fields for Stimuli of Different Sizes, *Am. J. Ophth.* **7**:843-850 (Nov.) 1924. Ferree, C. E.; Rand, G., and Monroe, M. M.: Critical Values for the Limits of the Color Fields in the Eight Principal Meridional Quadrants Taken Separately, *ibid.* **16**:577-589 (July) 1933.

8. Wentworth, H. A.: A Quantitative Study of Achromatic and Chromatic Sensitivity from Center to Periphery of the Visual Field, *Psychological Monograph* 183, Princeton, N. J., Psychological Review Company, 1930, vol. 40, pp. 1-189.

In figure 4 are given curves of the limiting and median values of the light minima from center to periphery for a small group of "non-pathologic" subjects and, by way of comparison, the results for 2 patients with glaucoma. These determinations were made in terms of foot candles falling on the gray stimulus previously noted, and the results were converted into millilamberts for the sake of a more independent and more nearly absolute specification of the stimulus.

In figure 5 are given curves of the limiting and median values of the minima for blue for a small group of "nonpathologic" subjects and, by way of comparison, the results for a patient referred to us as having glaucoma in the early stage. Examination in this case showed a contraction of the field and also a Bjerrum scotoma for a  $\frac{1}{2}$  degree blue stimulus but not for 1 degree—the size of stimulus used in making the determinations for the minima. The marked deviations and irregularities in the curve for the minima will be noted, particularly the high values of the minima in the Bjerrum region.

Figure 6 has been prepared to show the irregularities that may be found in the minima in some cases in which a diagnosis of pathologic disturbance has not yet been made. Whether these irregularities are due to the presence of more than usually large or dense blood vessels or to some other nonpathologic cause or whether they should be regarded as indicating an early stage of pathologic disturbance, we are not at this time prepared to say. The more striking irregularity in the case represented by figure 6 occurs, it will be noted, in the region of the blood vessels emerging from the blindspot. This, it will be remembered, is also the region of the Bjerrum scotoma.

In the introduction we have given what we believe to be a fair evaluation in general of the possibilities of the use of the method of limits and of the light and color minima in studies of the visual field. There remains to give a brief discussion of the value of the latter method in the present stage of development of clinical studies of the visual field. While the use of the light and color minima opens a promising field for future development and should be of great service to the forward-looking clinical worker, its value at present doubtless is in supplementing the method of limits in cases in which a more detailed study is wanted. The procedure used by many in examining a new patient would probably be first to block out the situation roughly with the method of limits and then to use the light and color minima to complete the study when more detailed information is wanted. The most important service will probably be in the great sensitivity which the method of minima provides for detecting small changes in a disturbance, advance or recession at the more critical and significant points in the field. Such uses of the minima do not require a prior establishment of norms and critical values and are, therefore, immediately available.



In general, it may be said too that in all phases of study of the visual field by the use of the minima there is less dependence on a comparison with norms and critical values than there is in the method of limits. The showing made on the minima by pathologic disturbances in the peripheral portion of the retina is so great as to leave little doubt of their presence without a meticulous comparison with norms or critical values. In this respect there is a similarity to the certainty that is afforded by a sector cut in the field in the use of the method of limits.

From all the foregoing considerations we believe that any competent and serious worker in clinical studies of the visual field will readily see the advantage of having as part of his equipment the attachment for determining the light and color minima and for making perimetric and tangent screen studies at different levels of illumination. The value and convenience of the attachment for certain types of research work and for laboratory and teaching work are equally obvious. With both the method of limits and the method of minima made more readily available for the purposes for which each is best suited and with the perimeter and its tangent screen standardized for the control of variable factors and provided with every known means for adding accuracy and delicacy in the use of the method of limits, together with the central vision scotometer described in a previous paper,<sup>9</sup> we feel that about all has been done that can be done at this time to render the study of the visual field complete, convenient and accurate.

#### SUMMARY

The following methods have been used to measure light and color sensitivity: 1. The light and color minima and light and color differences. These methods are customarily used to measure light and color sensitivity in central vision. They have not been used for practical work in peripheral vision, however, because of the lack of a suitable and feasible means of presenting at all points in the field a stimulus the intensity of which can be varied. 2. The limits of sensitivity (the perimetric method). With this method, the one customarily used to study sensitivity in peripheral vision, the points farthest from the center of the field at which a given stimulus is visible are determined. With the minima, or threshold, method, on the other hand, the intensity is determined at which a given stimulus is just visible at a given point in the field. The latter method is the older and without doubt the logical procedure; the former may be regarded as an indirect and substitute procedure, in many respects a poor one. 3. The light minimum for the discrimination of detail. The usefulness of this method in testing fitness for various kinds of work and types of ocular performance is

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9. Ferree, C. E., and Rand, G.: A Central Vision Scotometer, *Arch. Ophth.* 9:608-617 (April) 1933.

obvious. So far as we know, it has not yet been used to a considerable extent in clinical work, but we believe that it should have a place in every comprehensive program for the study of the characteristics of ocular diseases.

The shortcomings of the method of limits are discussed. Perhaps the most serious fault of the method is the examiner's inability to make the test where he wishes. Occasions demonstrating the need of full freedom in this respect are: during the early stages of detachment of the retina and during the course of reattachment; for all disturbances in the central, paracentral and midperipheral portions of the retina; during early stages of disturbances in all parts of the retina and during advance or recession of such disturbances. The complete adequacy of the method of minima for all these conditions and the serious inadequacy of the method of limits should be clear to all.

In recognition of the usefulness and need of the method of minima as well as the method of limits in clinical studies of the visual field, an attachment to the Ferree-Rand perimeter is described by means of which both the light and the color minima can be easily and conveniently determined at any point in the field and the method of limits extended to include the use of stimuli of different intensities in a continuously graded series. Some preliminary determinations of minima made with this attachment are given to show sensitivity gradients for light and color from center to periphery and variations in these gradients which may be caused by pathologic disturbances. A discussion is also given of the uses of the attachment as supplementary equipment for the study of the visual field by the method of limits.

The attachment is convenient and easy to use and can be readily substituted for the lamp house of the perimeter. It is of particular value (1) for a systematic study of the characteristics of ocular diseases, being the most thorough means of showing what parts of the retina are likely to be affected, and (2) for use in all cases (*a*) in which a more detailed study is needed than can be made with the method of limits, (*b*) in which a means more sensitive than is provided by the method of limits is needed for detecting a disturbance or slight changes in disturbance from time to time—advances or recessions, (*c*) in which quantitative knowledge is wanted of the relation of the sensitivity in the central portion of the retina to the sensitivity at any point in the peripheral portion or between different points in the peripheral portion and of the effect of adaptation on these sensitivities and relations (this opens a new field for both scientific and clinical study), (*d*) in which knowledge is wanted of the limits of the field of vision under different intensities of illumination and the effect of adaptation on these limits, testing the peripheral vision of night flyers, and (*e*) in which an extension of the versatility of the perimetric method is wanted beyond what is given by variation of size of stimulus and relation to background.

# Ophthalmologic Reviews

EDITED BY DR. FRANCIS HEED ADLER

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## STUDY OF TRANSILLUMINATION OF THE EYE

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This study of transillumination of the eye is for a twofold purpose: first, to review the literature and, second, to improve, if possible, on the methods, equipment and application of transillumination.

Before starting a review of the literature, I should like to define the terms used, namely, transillumination and diaphanoscopy. Funk and Wagnall's unabridged dictionary gives the most all-inclusive definition. Transillumination is described as "a shining through," with a specific medical definition of "the lighting up of an organ or part of the body by causing light to pass through it so as to perceive its contents or condition." The same dictionary defines diaphanoscopy as "examination of body cavities by the introduction into them of the incandescent electric light." It is obvious that the two terms are not exactly synonymous; however, they are often used interchangeably.

A review of the literature on transillumination brings forth the remarkable period of medical progress in the last fifty years of the nineteenth century, for it was during this period that the process of transillumination as an aid in ocular diagnosis was introduced. The pioneers of this once indispensable procedure deserve reverent admiration, for they had no electricity.

One is not at all surprised to find as the pioneer of transillumination, von Graefe. In 1868, in an article on intraocular tumors, he mentioned the use of transillumination in the differentiation between pressure staphylomas of the sclera and those caused by intraocular tumors.

Almost twenty years later, in 1884, Lange made use of this diagnostic method in the way in which it is still a valuable asset, that is, in distinguishing between serous detachment of the retina and detachment caused by choroidal sarcoma. Lange used as his transilluminator the light from an "ordinary gas flame" concentrated on the eye by means of a condensing lens. He noted that with the flame focused over the sarcoma, the light emerging from a dilated pupil was markedly reduced. Mules in 1888 mentioned again the transillumination of scleral staphylomas for the detection of tumors of the ciliary body. He considered

a thinned sclera necessary for a satisfactory interpretation of the findings from this method.

In the same year von Reuss reported the first instrument for transillumination. It consisted of a small glowing lamp, 1 cm. long and 3 cm.

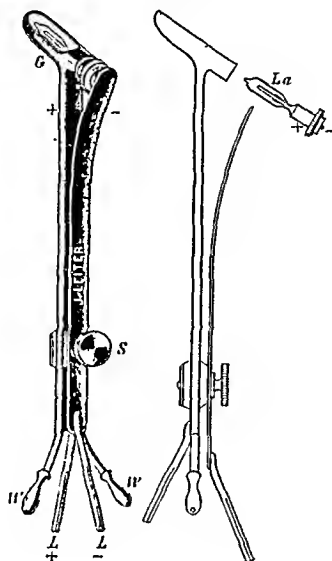


Fig. 1.—The von Reuss transilluminator. *W* indicates the water leads; *L*, the electric current leads; *S*, the screw adjustment; *G*, the water jacket, and *La*, the lamp.

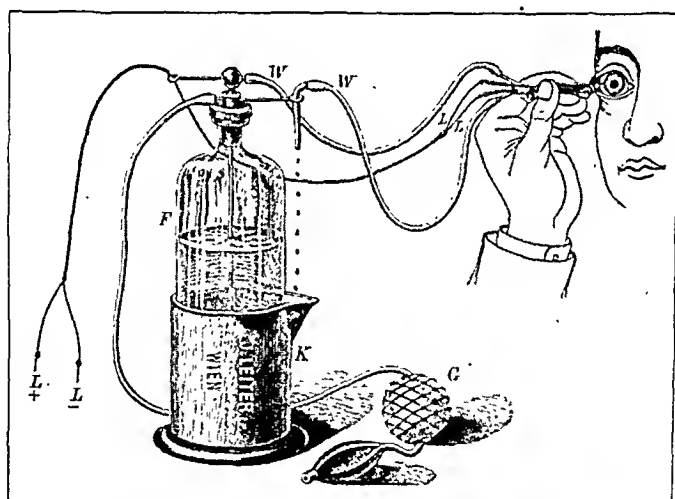


Fig. 2.—The von Reuss transilluminator in use with the water bottle. *W* indicates the water leads; *L*, the electric current leads; *F*, the water supply jar; *K*, the receptacle for return water, and *G*, the air bulb for forcing water through the instrument.

in diameter, contained in a small lantern. A metal pipe 2 cm. in length and 5 mm. in diameter, closed above with a glass window on one side, surrounded the lantern. The inside of the pipe was filled with cold

water which surrounded the lamp on all sides. The water flowed back and forth through the handle, which also held conductors for the electric current. This lamp was placed directly on the sclera. Leiter modified the instrument by using a glass rod to transmit the light and hence did away with the water jacket. Glass rods are still used in the modern instruments.

Von Reuss described transillumination through the cataractous lens, visualization of opaque foreign bodies, the peripheral portion of the retina and the ciliary body. He also foresaw great possibilities from this type of examination with better illumination.

In a correspondence to the *British Medical Journal* of Feb. 18, 1893, Stevenson reported that while examining a young person for disease of the antrum with a 5 candle power lamp he noticed that "not only the whole face seemed to blaze, but the eyes shot out from their uncontracted pupils a blood-red glare as from two miniature danger signal lamps." He found that with the light coming from the "back door" the pupil did not contract. Robertson later in the same month, in a

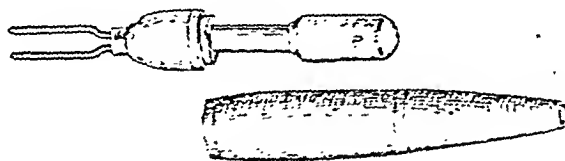


Fig. 3.—Rochon-Duvigneaud's transilluminator.

similar correspondence to the same journal, reported that he had noticed this phenomenon in 1892. He thought of it for use in diagnosing tumors but gave up the idea because of the opacity of the structures inferior to the orbit. "In only a restricted number of cases is the transillumination of the eye got at all, even when a 5 c.p. lamp is used." Here was the origin of posterior illumination.

Chilbret in 1893 made an instrument which Rochon-Duvigneaud perfected. This consisted of a small electric lamp, worked by an accumulator of 10 to 20 volts and encased in a horn sheath in contact with a glass cone 5 to 6 cm. long. It was used by direct application to the sclera.

Leber's hammer-shaped lamp appeared in 1901. It was composed of a small electric "glow lamp" enclosed in a metal receptacle. A short glass rod sheathed in rubber was in contact with the lamp. The light was conducted along the rod to the free edge. It did not heat and did not necessitate having the pupil dilated to get good transillumination. The following year the Sachs lamp was brought out. It was similar to Leber's instrument, but different in some details. It consisted of a 25 candle power lamp covered by a spherical metallic case 3 inches (7.6 cm.) in diameter. There was a cone-shaped projection of glass

which extended from the side of the sphere at right angles to the handle. The glass projector was silvered over the conical surface reflecting inward and was cased in hard rubber. Both of these lamps became hot quickly and were clumsy to handle.

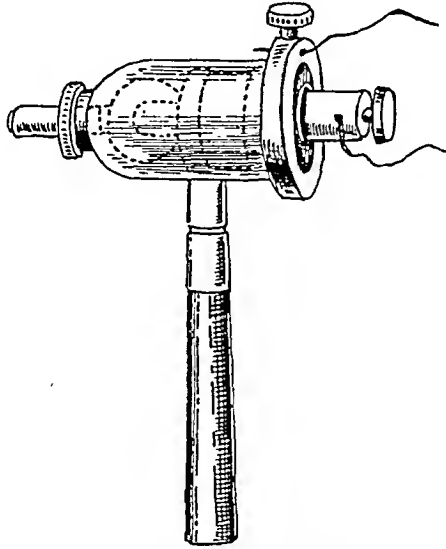


Fig. 4.—Leber's hammer-shaped transilluminator.

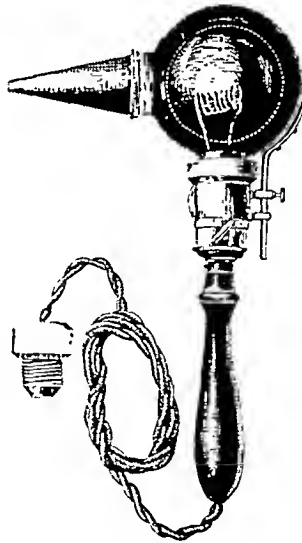


Fig. 5.—Sachs's transilluminator.

The next instrument of importance was the one presented by Würdemann in 1906, a handy attachment to the handle of the electric ophthalmoscope. It was composed of a 5 candle power bulb which replaced the bulb of the ophthalmoscope. On the end of the bulb was a lens. There was a cone-shaped screw cap. Inside the cap was a

5 mm. glass rod  $\frac{3}{4}$  inches (1.9 cm.) long, which came in contact with the lens on the bulb. The rod extended a fraction of a millimeter beyond the end of the cone. The light protruded almost parallel, and only 1 volt was necessary to light the bulb.

In the same year Lange introduced his original transilluminator, which was a considerable improvement on the earlier ones. His instrument was made with a hard rubber cylinder 5 cm. long and 2.5 cm. in diameter. The lamp was a 10 volt "glow lamp." The cylinder was capped by a nickel clasp in which was inserted a glass rod 5 cm. long. The end of the rod was curved and ended in a point 2 mm. in diameter, which permitted its use far back on the globe. It had a small key which controlled the current.

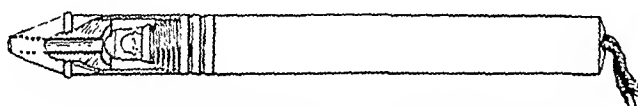


Fig. 6.—Würdemann's transilluminator.

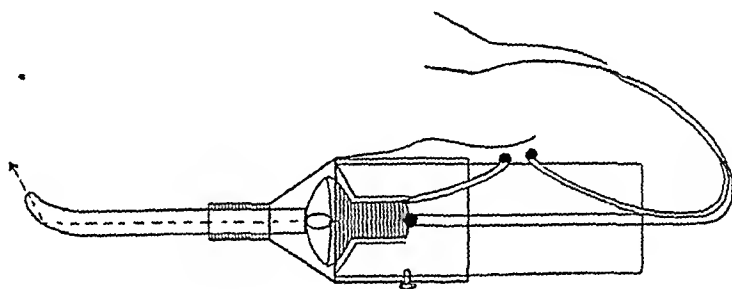


Fig. 7.—Lange's original transilluminator.

Hertzell in 1909 produced an instrument for transilluminating the eye by using the phenomenon described in 1893 by Robertson and Stevenson. The ophthalmodiaphanoscope, as he called it, consisted of an 80 candle power electric bulb strengthened by a reflector, which raised the intensity of the light to 100 candle power. The bulb was mounted in metal with connecting plugs, and the whole was encased in glass, leaving a space for a water bath. The lamp was used in the patient's mouth, far back. For the best results it was advised that the patient wear a black mask with holes for the eyes. When the light was on, the pupil, choroid and retina could be seen. The observer had to be close to the patient, and a lens was necessary to see myopic eyes well.

Langenhorn devised a special tip for this lamp and used it as any ordinary transilluminator.

The next development of especial interest was in 1911—Lancaster's direct transillumination of the posterior segment of the eyeball through

an incision in the conjunctiva and Tenon's capsule. He devised a simple instrument for this special work, consisting of a small tungsten lamp on the end of a copper tube 70 mm. long and 3 mm. in diameter, flexible enough to allow bending to fit the curvature of the eyeball. The

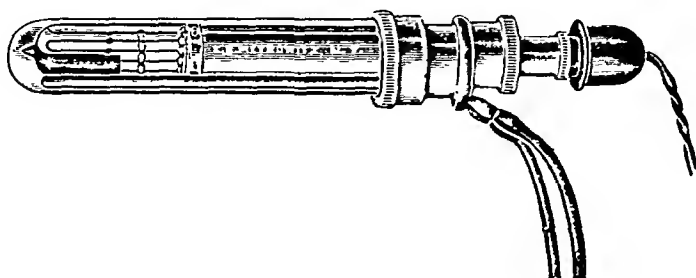


Fig. 8.—Hertzell's ophthalmodiaphanoscope.

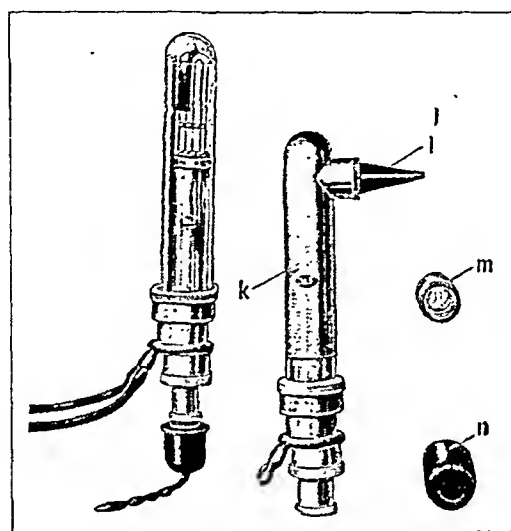


Fig. 9.—Hertzell's ophthalmodiaphanoscope with Langenhan's special tip. *k* indicates Langenhan's cap; *l*, the transilluminating cone, and *m* and *n*, special mountings for the cone.

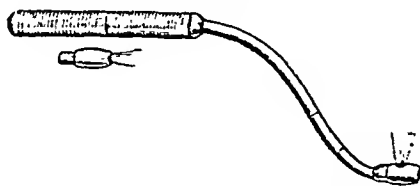


Fig. 10.—Lancaster's posterior transilluminator.

current was supplied by pocket flashlight batteries. Because of the trauma this method has only a limited use but is indicated in cases of posterior masses that should be proved to be either neoplastic or inflammatory.



In 1916 Reeder, of Chicago, developed a transilluminator with a long slender projection on an ordinary battery handle. This projector was to be placed between the lip and the alveolar ridge. Lighting of the antrum, the lower margins of the orbit and the pupil was accomplished by this simple procedure. The lacrimal sac could be lighted by placing the light in the nostril at the anterior end of the middle turbinate.

Lange improved on his original transilluminator and, using the same principle and including the advantages of the Sachs lamp and a brighter light, developed the transilluminator which is now standard. This consists of a small metal filament lamp lighted by 0.4 ampere at 3.5 volts derived either from a battery or a house current with a suitable transformer. The light is made more intense by a small condenser at

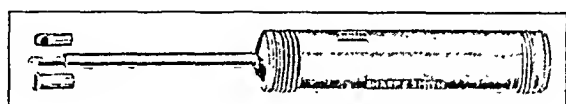


Fig. 11.—Reeder's transilluminator.

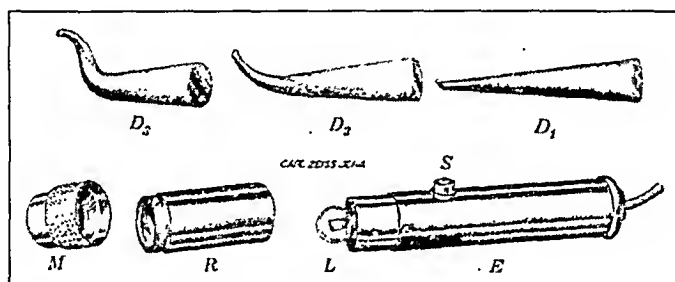


Fig. 12.—Lange's modern transilluminator.  $D_1$ ,  $D_2$  and  $D_3$  indicate the glass transilluminating cones;  $M$ , the mounting for the cones;  $R$ , the cap and condensing lens;  $L$ , the lamp;  $E$ , the handle, and  $S$ , the sliding current control.

the exit opening of the glass cone which forms an image of the source of light. The light can be switched on and off by a sliding contact on the handle. Figure 12 shows its component parts.  $D_1$ ,  $D_2$  and  $D_3$  are the three glass cones, made of fine optical glass, silvered and protected by a substance which permits their being sterilized in a solution of mercury bichloride. The curves on the cones are adapted for transilluminating far back on the globe and in places where other types of transilluminators cannot be placed.

Strampelli in May 1935 described a novel instrument consisting of a transilluminator and diathermic electrode combined. In August of the same year Pavía, of Buenos Aires, suggested the use of the Lange transilluminator and observation through a contact lens to locate tears in a retinal detachment. In October 1935 Pavía and Dusseldorp

equipped a Lange transilluminator with diathermic electrodes and used this on experimental animals to locate tears and to treat retinal detachment simultaneously. As far as I have been able to determine, this is the most recent development in transillumination.

In 1936 J. J. Clegg, of Manchester, England, reported that he had made an instrument for posterior transillumination. It is similar to Lancaster's transilluminator and is used in the same way. He considered the trauma of introduction negligible because the muscles need not be disturbed.

Many other instruments have been made, but those described have been the most significant in the history of this interesting method of

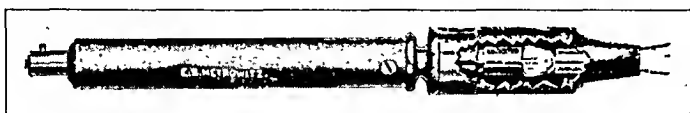


Fig. 13.—Maijgren's transilluminator.

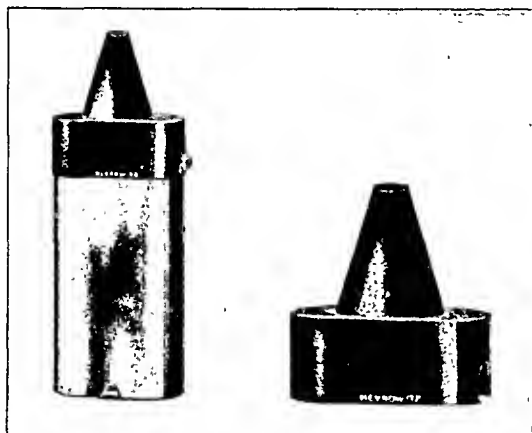


Fig. 14.—Holbrook Lowell's "inexpensive pocket transilluminator."

ocular examination. I have pictures of Holbrook Lowell's "inexpensive pocket transilluminator" presented in 1911, of Maijgren's, which is similar to the Würdemann instrument, and of an old combination operating lamp and transilluminator. Other instruments have been devised by Gartner, Hirnbacker, Wolz, von Pflugk, Lindahl, Guist, Dalen and Ernest Clarke.

#### USES OF TRANSILLUMINATION

Although many uses for transillumination have been suggested at various times, the one specific thing for which it was first used—detection of intraocular tumor—makes transillumination at this time an

important diagnostic measure. The other observations which have been made were of great importance in the late nineteenth, and early in the twentieth, century, but at present little attention is paid to any except identification of the tumor. Most of the findings that were dependent on transillumination for detection are now observed with the slit lamp and corneal microscope. Some transillumination, however, is done with the slit lamp.

Important conditions of the cornea, iris, ciliary body, lens, sclera, vitreous and retina have been diagnosed by transillumination. The conjunctiva has received some attention, but, as far as I can discover, there has been no systematic work on transilluminating the lids.

The cornea received early attention. Foreign bodies and rust rings were found to show up well when transillumination was used. Würdemann described the phenomenon of rendering a corneal leukoma trans-

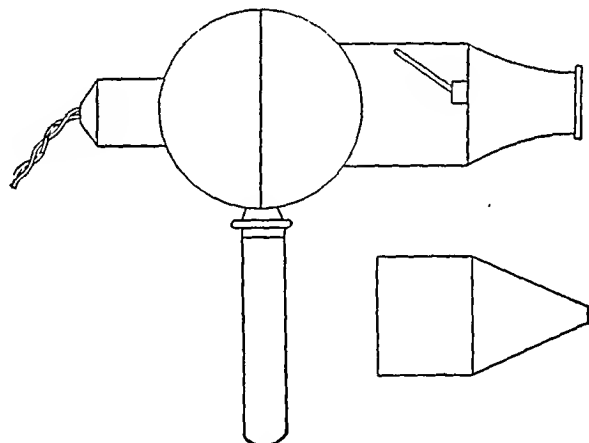


Fig. 15.—Old operating lamp and transilluminator.

lucent enough to make possible a study of the iris, which is invisible behind the leukoma when viewed by oblique illumination. Veullers also mentioned this and added observation of the iris behind a persistent pupillary membrane. According to Brown's translation of Fuchs's book, small unevennesses of the cornea can be well brought out by throwing light into the eye, as in the shadow test, and observing the cornea in the transmitted light. Deposits on the posterior surface of the cornea can also be found by this method. Butler, in his "An Illustrated Guide to the Slit-Lamp," stated that "retroillumination, or transillumination, is one of the most valuable assets of the slit lamp." He referred here to light reflected from a "suitable mirror such as the iris to study the cornea" rather than what is ordinarily considered transillumination.

Würdemann in 1908, although he was not the first to describe it, dwelt at length on the ring of light which appears around the cornea

when the transilluminator is in certain positions. He interpreted this as the circumlental space and noted that in the glaucomatous eye the space was narrower than in the normal eye. A correct interpretation of this light ring had apparently previously been given by Edgar Thompson, of New York, who recognized that it was the filtration angle to which the ring corresponded. He observed that adhesions to the filtration angle decreased the width of the light ring. Jackson corroborated this theory, but he believed that the light was transmitted across the anterior chamber. Fridenberg in 1910 showed that the light is reflected back and forth between the anterior and the posterior surface of the cornea and is scattered in the region of the sclera corresponding to the spaces of Fontana. He asserted also that showing of the circumlental space by transillumination was an optical and physical impossibility because of the pigment barrier of the iris and the transparency of the lens. He further proved his theory by showing that aphakia did not affect the light ring.

Aside from the reactions from tumors, the iris and ciliary body have received the most attention in the field of transillumination. The normal ciliary body is visible in the anterior part of the eye as a dark shadow band when the normal eye is transilluminated. Abnormalities in size and shape are easily observed, as are deficiencies in pigment. Von Reuss in 1888 recognized this shadow as the ciliary body. Many observers have since described it. The most important reason for transilluminating this area is for the diagnosis of tumors and for the study of the extent of traumatic conditions involving this region. Duke-Elder, in his "Textbook of Ophthalmology," advised the use of the slit lamp beam shot through the pupil for good visualization of the ciliary body. Posteriorly, the choroid field shows red, whereas the ciliary body forms a dark ring in front of the red. A translucent space 5 to 2 mm. in width between the dark ciliary region and the cornea represents the filtration angle.

Transillumination of the iris presents the most interesting picture of all parts of the eye. There are many variations of the results, even in normal eyes. Rochon-Duvigneaud pointed out in 1894 that some blue irides were more opaque than certain brown ones. He also observed that the most marked differences were in the lesser iris circle and that a slight translucidity was present in the greater circle, particularly toward the root of the iris, where alternating bands of light and dark could be seen. Pigment defects in the iris show plainly by transillumination. The defects permit light to pass through. These may be congenital, as in the albino, or the result of disease or of trauma. Oftentimes the path of a foreign body that has penetrated the iris may be traced by the light coming through the region where the foreign body has produced a pigment defect. Transillumination of the iris is

a valuable asset in deciding the site at which to perform an optic iridectomy. For study of the iris by this method a contracted pupil is best, to obviate difficulties, as Souter expressed it, "from the Venetian blind effect of the dilated pupil."

Transillumination of the lens was done in 1888 by von Reuss, who observed that the cataractous lens is transilluminated almost as well as the normal lens. He saw that foreign bodies in the cataractous lens could be easily detected by this method. Many other observers since then have agreed that this is an important diagnostic fact. Fridenberg showed that a postcataractous membrane stopped light only if it contained blood.

Occasionally, opacities of the vitreous can be made visible to several persons at a time by transillumination, according to Rochon-Duvigneaud. However, he stated that they are not as well seen as with the ophthalmoscope.

Diseases of the retina have been studied by transillumination, but all observers are agreed that the visualization is not as good as with the ophthalmoscope. Of course, the most important retinal condition to be studied by transillumination is detachment; however, the detachment is transilluminated not to study the retina in detail but to determine the causation of the separation, that is, whether or not a tumor is present or if a retinal tear has been sustained.

From the earliest use of transillumination down to the present day the principle in detecting tumors has not been changed. The fact that a new growth does not transmit light, so that when a source is placed over the tumor no light or little light is transmitted through it, remains as the basis for the diagnosis. All the instruments and methods described go back to this fact for determining the presence of a tumor. Several difficulties, however, are met. Marple in 1906 pointed out that in some cases of sparsely pigmented tumor a too bright light used for transillumination would not be stopped by the growth. Suker in the same year reported 2 cases in which transillumination was misleading because a fresh hemorrhage or a partly absorbed hemorrhage produced an accentuated red reflex and obscured the shadow of the tumor. On the other hand, Würdemann showed that at times even a slight intra-ocular hemorrhage prevents transillumination. Negroes also present much difficulty because of the darker pigmentation. Griscom in 1915 reported the study of a series of Negroes in whom transillumination was utterly impossible because of the pigmentation of the normal tissues.

In the last few years transillumination has been used as a means of finding tears in a detached retina and, as has already been mentioned, is used in conjunction with diathermy in operations on detachments.

So it seems that at present transillumination, which was once considered a part of every routine examination, has passed somewhat out

of the picture. Its use now, exclusive of the retroillumination described by Butler in his treatise on slit lamp microscopy, is limited to two fields, the detection of intraocular tumors and the localization of retinal tears in cases of detachment. Like so many of the old medical tests which have given place to the new, this one still has many advantages that have not been outclassed by present methods.

The National Electric Instrument Company designed and developed the prism transilluminator.

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# Clinical Notes

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## A SIMPLE METHOD OF PRODUCING ANESTHESIA DURING REMOVAL OF TRANSPLANTS OF MUCOUS MEMBRANE

MARSHALL STEWART, M.D., D.D.S., VALHALLA, N. Y.

It is not the purpose of this paper to modify the surgical technic of the prevailing procedures on the lid, such as the van Milligan and the Webster operations. The article deals solely with pain associated with removal of transplants of mucous membrane from the lip and cheek.

The earlier operations on the lid were performed with the patient under a general anesthetic.<sup>1</sup> Later a 1 per cent solution of procaine hydrochloride was used to anesthetize the eyelid. Many surgeons use a topical application of a 10 per cent solution of cocaine hydrochloride in an attempt to alleviate the pain which usually accompanies removal of a graft of mucous membrane from the lip and cheek.

Dentists, oral surgeons and those familiar with regional anesthesia about the face have known for years that infiltration of procaine hydrochloride into the labial fold anterior to the incisor teeth produces anesthesia in the lips as well as in the incisor teeth. The mucous membrane of the cheek can also be blocked by anesthetizing the upper and lower nerve filaments within the mouth—the buccal sulci. The lower lip is the most frequent and accessible location for obtaining plants.

The nerve supply of the site of election, the lower lip, is supplied by branches of the mental nerve, its fellow on the opposite side and occasionally branches from the cervical nerves which pass up over the chin.<sup>2</sup>

### TECHNIC

It has been found best first to block the nerve branches of the lower lip and then to cocainize and infiltrate the eyelid with procaine hydrochloride in the usual manner. These steps will shorten the operative time and prevent undue exposure of the delicate graft of mucous membrane.

The lower lip is grasped gently between the thumb and the index finger and is pulled outward, showing the septum-like frenulum in the midline at the symphysis

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Read before the Memphis Society of Ophthalmology and Otolaryngology, Nov. 13, 1934.

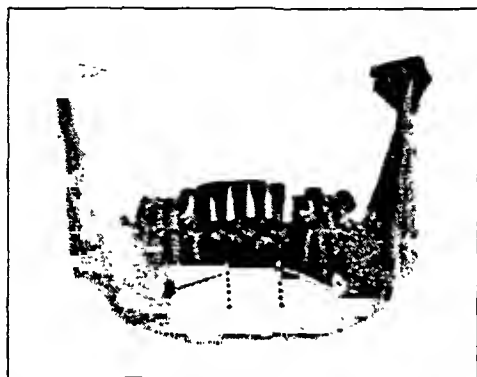
Since this paper was read, this method of anesthesia has been used routinely at the Memphis Eye, Ear, Nose and Throat Hospital.

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mandibulae. The floor of the mucous membrane-lined sulcus will be raised. This sulcus lies between the labial surface of the gums of the incisor teeth and the inner surface of the lower lip.

With an applicator held in the other hand the site of the future needle injection on each side of the frenulum is swabbed with a small amount of a weak solution of mercurochrome. The lip should still be held out with the fingers. The hypodermic needle is inserted in the floor of the sulcus, halfway between the surface of the gums and the inner surface of the lower lip. The needle should be about 2 cm. in length. About 1 cc. of a 1 per cent solution of procaine hydrochloride is injected 1 cm. lateral to the frenulum, care being taken not to slide the needle on the periosteum, as this is sometimes painful. The needle is inserted downward in a vertical manner about 1 cm. This distance may be more or less than 1 cm., depending on the amount of absorption of the alveolar process, which takes place in older persons or where teeth have been extracted for some time. In order to prevent a double needle puncture, the needle is pulled partly out and is then directed laterally, backward and slightly downward for 1.5 or 2 cm. in the



The mental foramens are indicated by the black circles and the direction of the needle by the dotted lines.

proximity of the mental foramen, where 1 cc. of a solution of procaine hydrochloride is deposited. It is unnecessary and painful to enter the mental foramen.<sup>2</sup>

The mental foramen is located about 2.5 cm. lateral to the symphysis mandibulae and 2 cm. below the gingival margin of the bicuspid teeth. The foramen lies between the apexes of the lower first and second bicuspid teeth, sometimes called premolar teeth.

The solution of procaine hydrochloride is deposited anterior to the mental foramen. Anesthesia will readily take place, as the main nerve branches pass anteriorly and medially toward the symphysis mandibulae. The injection is repeated on the opposite side of the mandible in a similar manner because of an overlapping of nerve filaments from the opposite mental nerve and cervical branches which come up over the chin. The blocking of sensation in the lower lip takes place in a few minutes. The actual injection into each side can be accomplished in less than a minute. The patient will soon experience a feeling of numbness and thickness of the lower lip. Anesthesia in the lower lip should last about an hour. The transplant of mucous membrane is removed in the usual manner.

## SUMMARY

This painless modification of the removal of transplants of mucous membrane has been used at the Memphis Eye, Ear, Nose and Throat Hospital by the staff and resident surgeons in 5 cases. The entire procedure in all cases has been devoid of pain. There has been no sloughing of the transplant, because the nerve filaments are blocked distant to the site of removal of the graft. The protoplasmic poison, cocaine, is eliminated as a topical anesthetic, thereby preventing interference with normal cell metabolism, the prime requisite of plastic surgical procedures. I have blocked the mental nerve in over 10,000 cases without apparent introduction of infection.

## DISCUSSION

DR. RALPH O. RYCHENER, Memphis, Tenn.: I have used this method of anesthesia in several cases and have found it to be very satisfactory.

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OPHTHALMOLOGIC ASPECT OF THE MODERN TREATMENT  
OF POSTENCEPHALITIC PARKINSONISM (THE  
BULGARIAN CURE)

MAX HERZOG, M.D., CHICAGO

The purpose of this report is to call the attention of the American ophthalmologists to a new treatment for postencephalitic parkinsonism, one phase of which treatment is of definite ophthalmologic interest.

Since 1926 an herb collector by the name of Raeff in a Bulgarian village has been successful in treating patients with this disease with a secret medication. Queen Elena of Italy became interested in these cures and sponsored an institution in Rome for the scientific and clinical evaluation of the Bulgarian procedure. Remarkable work has been done by that institution under the leadership of Panegrossi. Later von Witzleben, in Germany,<sup>1</sup> started work along the same line.

It has been established that "postencephalitic parkinsonism" is a misnomer and that the disease should better be renamed "chronic encephalitis." The Bulgarian treatment consists of the administration of a percolate of the root of the belladonna plant by mouth combined with gymnastic and dietetic measures. This treatment must be continued for many years, usually until the patient's death. The rationale and technic of the treatment and its difference from ordinary medication with atropine cannot be discussed here. It may be said, however, that the reports have been very optimistic.

The alkaloid is given in such doses that as a by-effect the pupils of the patient are kept constantly dilated and the accommodation paralyzed. Consequently, the patient has to wear convex glasses for close work at any age.

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1. von Witzleben, H. D.: (a) Die Behandlung der chronischen Encephalitis epidemica mit der "bulgarischen Kur," Berlin, Julius Springer, 1938; (b) Schweiz. med. Wchnschr. 68:1352 (Dec. 10) 1938.

In the United States, where mydriatics and cycloplegics are used extensively for refraction, ophthalmologists are careful not to precipitate a glaucomatous attack in patients over 40 years of age by dilatation of the pupils. In this connection it is interesting to note that the physicians applying the Bulgarian treatment conducted an experiment on a large scale by keeping their patients' eyes in a state of mydriasis for many years without even considering the possibility of precipitating a glaucomatous attack. At least several hundred patients—many of them over 40 years old—have been treated in one institution in Germany without such an occurrence.<sup>2</sup> The difficulty of using the Bulgarian cure for glaucomatous patients, however, has been realized and discussed.<sup>1a</sup>

It has been estimated that there are 20,000 to 30,000 patients with chronic encephalitis living in Germany. There must also be a considerable number of them in the United States. If the Bulgarian treatment should become more popular in this country, it will be the duty of the ophthalmologists to watch this new development. It certainly is important that the new method, if valuable, should not be discredited by ocular accidents.

2. Personal communication to the author.

## MELANOSIS OCULI

### Report of a Case

JOSEPH ZIPORKES, M.D., NEW YORK

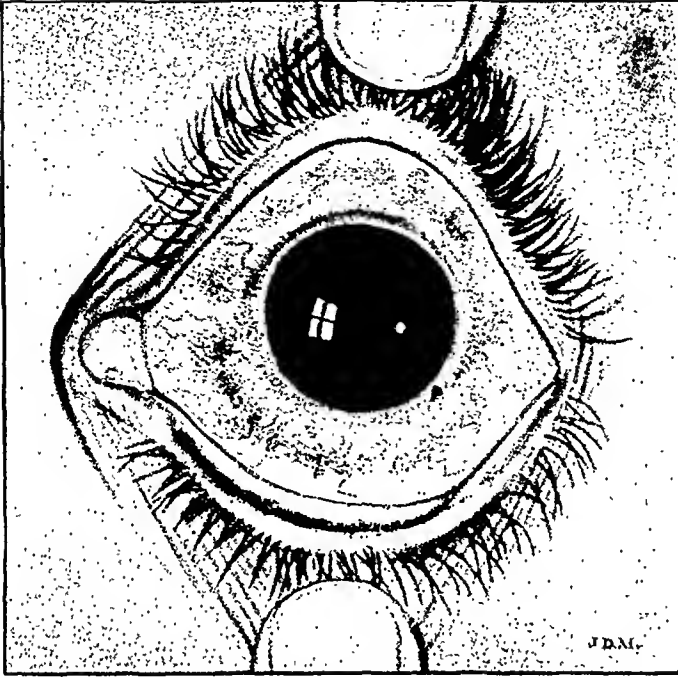
E. B., a girl aged 17, was first seen at the ophthalmic clinic on April 22, 1939, with the complaint that the left eye had been discolored since birth. The condition had not changed. The patient became sensitive about her appearance and wished to know whether anything could be done to reduce the disfiguration. There was no history of a similar condition in any other member of her family. Examination showed a well developed brunette. She had had the usual diseases of childhood. There was no history of fractures. She had a deeply pigmented spot in the middle of the lower lip, but there were no other pigmented areas on her body.

Vision in the left eye was 20/30; with a -50 sph. combined with a -75 cyl., axis 180, it was 20/20. The pupillary reactions and accommodation were normal.

The skin of the lids of the left eye and of the left side of the forehead was more deeply pigmented than on the right side. The inner border of the free margin of the lower lid was rimmed with brown pigment extending from the canaliculus to the external canthus. There was a small amount of similar pigment near the upper canaliculus.

The bulbar conjunctiva was studded with brown pigment granules, which were especially numerous on the inferior nasal quadrant. Surrounding the limbus and seen better with the slit lamp were similar brown pigment granules, which extended a little into the superficial layers of the cornea. A pigment clump was visible macroscopically at the limbus at 5 o'clock.

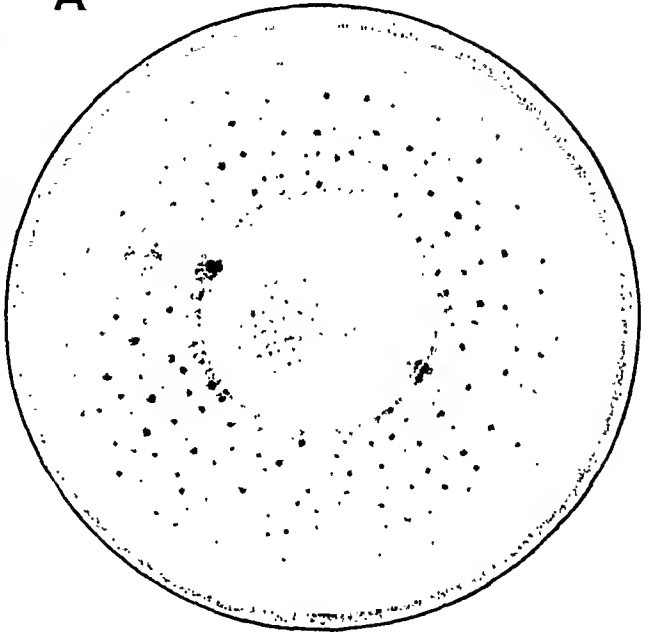
Presented before the Clinical Society of the Knapp Memorial Eye Hospital, May 25, 1939.



A



B



C

*A*, photograph showing discoloration of the lid and sclera and the pigment streak along the free border of the lids; *B*, a slit lamp drawing showing the scleral discoloration, the pigment on the back of the cornea and the presence of nodules on the iris, and *C*, the appearance of the iris with profuse pigmented elevations.



A rather striking bluish purple discoloration of the sclera was present. It almost completely surrounded the cornea, except for a 2 mm. gap nasally, and extended from the edge of the cornea to a distance of 7 to 10 mm. from the limbus. This discoloration, however, did not extend to the fornix.

On the endothelium of the cornea, particularly in the lower nasal third, were pigment remains of a persistent pupillary membrane; otherwise the cornea was clear.

Pigment remnants of a persistent pupillary membrane were present on the anterior lens capsule.

The iris was dark brown, thick and velvety. On the anterior surface were many cone-shaped and hemispheric mounds or elevations about 1 mm. high. They were only slightly less pigmented than the rest of the iris.

The fundus was chocolate colored.

The media were clear.

Vision in the right eye was 20/200; with a —4 sph. it was 20/20. The eye appeared normal in every way. The iris was brown.

#### COMMENT

This relatively uncommon condition is due to excessive pigmentation in the mesoblastic layers encircling the secondary optic vesicle and is a congenital defect. In only a few cases has it been present in more than one member of a family. It is usually bilateral. The discoloration of the sclera is due to pigment in the superficial layers and not to the thinning of the sclera, as in the case of blue sclerotics.

The hemispheric elevations on the iris are due, according to Collins,<sup>1</sup> to hyperplasia of the surface endothelium with proliferation of pigment in the chromatophores. The posterior pigment epithelium of the iris is normal in these cases. Ida Mann<sup>2</sup> stated that similar "mammillations" are present normally in certain species of frogs.

It is rare for melanosis bulbi to develop in these cases, though Reese<sup>3</sup> described the microscopic observations in a case of unilateral melanosis bulbi in a woman of 65 in which a melanosis was present. He stated that "melanosis bulbi" is potentially dangerous, especially in the later years of life. Usher,<sup>4</sup> however, reported 6 cases in which he was able to reexamine the patients from six to twenty years after the first examination. Two showed absolutely no change and 2 showed doubtful changes; the color of the eye of 1 became slightly darker, and the scleral discoloration of the last patient observed had extended slightly.

In the case of Davis,<sup>5</sup> which he reported in 1927, there was no material change from the time of the first observation in 1910. A case almost identical with the one here described was reported in 1925 by J. and H. Friedenwald.<sup>6</sup>

Contact glasses with the scleral portion painted a normal color was suggested for the disfiguring appearance.

1. Collins, E. T.: *Tr. Ophth. Soc. U. Kingdom* 40:145, 1920.

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4. Usher, C. H.: *Brit. J. Ophth.* 16:671, 1932.

5. Davis, A. E.: *Tr. Am. Ophth. Soc.* 25:89, 1927.

6. Friedenwald, H., and Friedenwald, J. S.: *Arch. Ophth.* 54:51, 1925.

## REDUPLICATION OF DESCMET'S MEMBRANE

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PORTLAND, ORE.

The condition reported here consists of a uniform band of almost transparent membrane extending obliquely across the pupil within the anterior chamber. It occurred after a birth injury and is described because it differs from other membranes reported in the literature as following such an injury.

The causation of this condition lies in the splitting of Descemet's membrane due to compression of the globe against the bony wall by forceps. Tears<sup>1</sup> in the membrane are usually due to either compression or distention. They are found most often in young persons and are seen in association with buphthalmos, secondary glaucoma, retinoblastoma with distention, keratoconus, progressive or high myopia and compression or corneal injuries from external force.<sup>1</sup>

In the diagnosis this condition must not be confused with those congenital anomalies in which there are associations with the anterior layer of the iris stroma, resulting in membranes which are adherent to the iris and at times stained with iris pigment. When the condition is properly diagnosed, an attempt should be made to find the cause if possible. As previously mentioned, tears in Descemet's membrane may have many causes, but membranes of hyaline network may be due to other causes,<sup>2</sup> such as inflammation. Interstitial, or chronic, keratitis, herpes or apparently any cause which will produce hypotony with ensuing folds in Descemet's membrane can theoretically, at least, produce a reduplication of the membrane. It has long been known that when the membrane is once ruptured the folds in it curl up,<sup>3</sup> and a deposition of new material on it may produce a glassy membrane.

## REPORT OF A CASE

L. Z., a white schoolgirl of 13 years, first came to the ophthalmic clinic of the University of Oregon on Feb. 7, 1939. Her history revealed that pregnancy had been normal, but her birth was difficult, necessitating the use of forceps. The right eye was swollen shut the first four days of life, and the cornea was so cloudy that the pupil could not be seen during the first five months of life. The mother stated that an oculist considered draining fluid from the eye at this time, but this was not done. When the child was seen at 9 months of age by her pediatrician<sup>4</sup> the eye had not yet healed, the head was unusually large, the

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From the Ophthalmic Clinic of the University of Oregon Medical School.

Presented before the Oregon Academy of Ophthalmology and Oto-Laryngology, Portland, April 6, 1939.

1. Duke-Elder, W. S.: *Textbook of Ophthalmology*, St. Louis, C. V. Mosby Company, 1938, vol. 2, pp. 1869-1876.

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3. Lloyd, R. I.: *Tuberculosis of the Eye*, *Am. J. Ophth.* **13**:753, 1930.

4. Dr. H. L. Saylor, Huron Clinic, Huron, S. D.



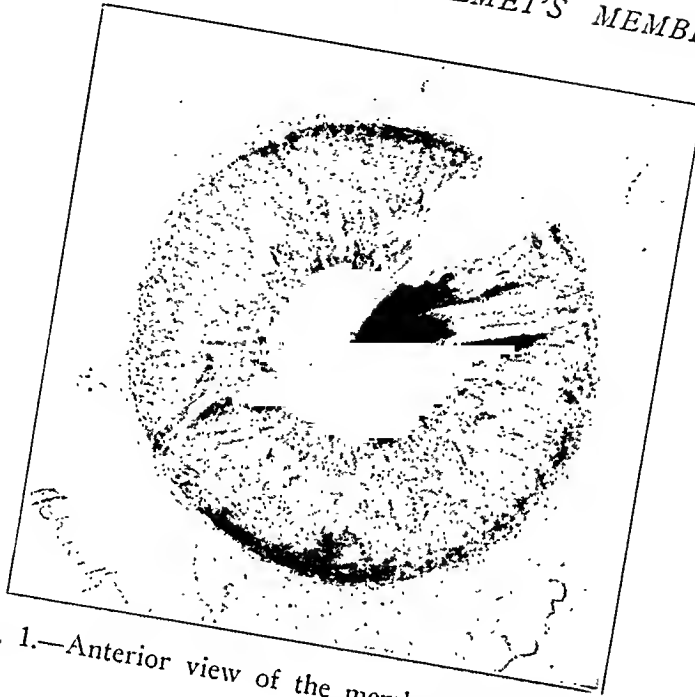


Fig. 1.—Anterior view of the membrane (magnified).

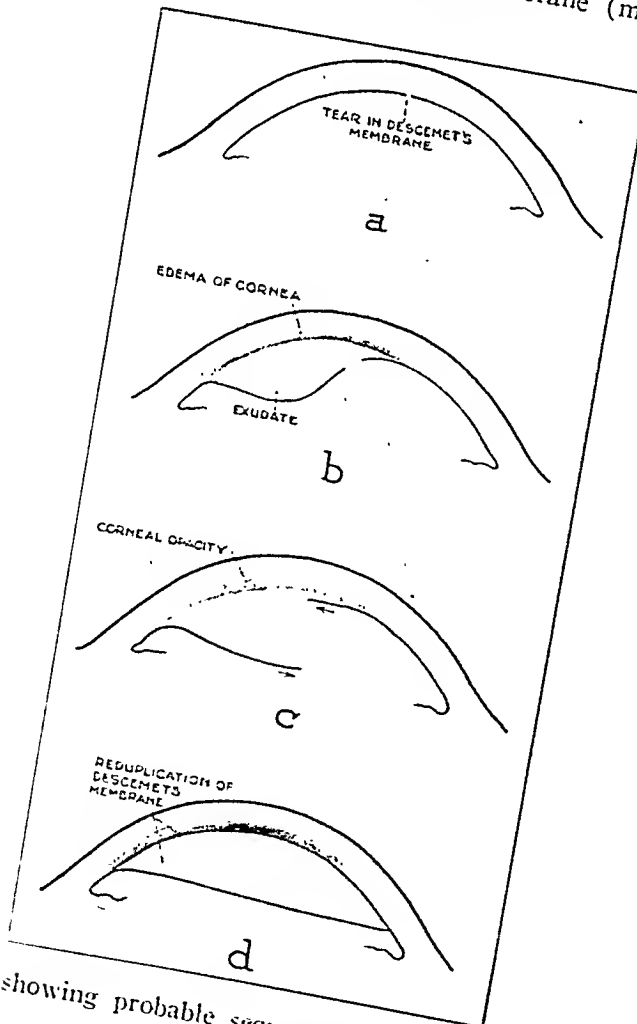


Fig. 2.—Diagram showing probable sequence of steps in the formation of the membrane.

fontanels were widely separated, and the patient was unable to hold her head erect. A diagnosis of injury to the right eye and hydrocephalus was then made. On entering the clinic the patient's only complaint was poor vision, and the general physical findings indicated that she was in good health otherwise. Urinalysis and serologic and hematologic examinations gave negative results. The department of otolaryngology reported only normal findings, including the results of audiographic tests. Ocular examination revealed vision of 2/200 in the right eye and 20/70 in the left eye (without correction).

The child was found to be wearing the following correction: in the right eye, a  $-1.00$  sph. (apparently to match the left eye), with no improvement, and in the left eye, a  $-0.75$  sph.  $\ominus$  a  $-1.25$  cyl., axis 75, which gave vision of 20/50.

Under atropine cycloplegia retinoscopic examination revealed that these findings could not be improved with any lenses, though the left eye showed myopia of 18 diopters with a small amount of astigmatism. Muscle balance by cover tests and the Maddox test showed no vertical imbalance, but there was esotropia, varying from 5 to 20 degrees. There was slight nystagmus of the vibratory ocular or pendular type on fixation of the right eye alone. Intraocular tension (Schiotz) was 23 in the right eye and 16 in the left eye.

A roentgenogram revealed considerable compression and sclerosis of the right optic foramen, the left being normal.

Under the slit lamp the right eye showed a nearly transparent membrane, stationary in the anterior chamber from about "11 to 5 o'clock." It was not tremulous on movement of the globe, but the posterior cornea was seen to be intact, and a deeper focus was necessary to visualize the membrane, which was better seen by retroillumination. The iris appeared normal. There was also a corneal scar of about 2 mm. in width extending to the deeper layers from about "1 to 7 o'clock," whereas the glassy band was about 2 mm. in width above and broadened to about 3.5 mm. at the lower attachment. Figure 1 brings out the shape and direction of the membrane.

The history would seem to indicate not only a traumatic cornea from a birth injury but an ensuing glaucoma, either of which could have produced the tear. The high myopia might also have caused the same. Since Lloyd<sup>5</sup> has shown that the typical birth injury of the cornea produces most of the foregoing findings, we are inclined to believe that the original tear in Descemet's membrane occurred at birth. Figure 2 shows the possible formation of such a membrane as described.

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5. Lloyd, R. I.: Birth Injuries of the Cornea and Allied Conditions, *Arch. Ophth.* 19:462 (March) 1938.

## BILATERAL RING SCOTOMA OF FIVE YEARS' DURATION

FRITZ MEYERBACH, M.D., SHANGHAI, CHINA

AND

RICHARD D. LOEWENBERG, M.D., SAN FRANCISCO

"The subject of ring scotoma though not even mentioned in the majority of our text books is one of great interest, and its careful study, together with a faithful record of cases, might not improbably

add much to our present knowledge . . . few attempts have been made to deal exhaustively with the subject" (Hancock<sup>1</sup>).

These lines, written thirty-three years ago, are still justified. The conditions in which Hancock observed ring scotoma have not increased much. He named retinitis pigmentosa, retinitis, choroiditis, retino-choroiditis, lesions of the optic nerve with or without optic neuritis, glaucoma, idiopathic night blindness and myopia. Since then only few additional causes have been described. These are: blinding by diffuse lights, especially in aviators (Zade<sup>2</sup>); abnormal functional fatigability (Gelb and Goldstein<sup>3</sup>); migraine (Zentmayer<sup>4</sup>); accidents (A. Fuchs<sup>5</sup>); callus from fracture (Lillie and Adson<sup>6</sup>), and tobacco (Krimsky<sup>7</sup>). The encyclopedia of von Schieck and Brückner<sup>8</sup> scarcely mentions this condition.

Therefore the addition of a new case is justified on account of some remarkable new features: Etiologically, all known factors as previously described could be ruled out; the clinical picture of bilateral ring scotoma remained monosymptomatic, and the therapeutic effect of estrogen hormone was impressive.

#### REPORT OF A CASE

*History.*—Mrs. Q., a Portuguese, aged 44, came to our office in June 1937. Her eyesight had gradually decreased in the last five years. She had been treated by many practitioners and specialists without improvement.

There was no consanguinity in her ancestry. Her father died from meningitis at the age of 39; a brother died from heart disease. All other seven brothers and sisters were healthy. The patient had one healthy daughter. She had had no miscarriages or abortions and had never been seriously ill. Her first menstruation occurred at the age of 11 years, and the periods had always been regular.

The question whether the patient had suffered any injury (shock, wound or blow) was definitely answered in the negative.

The patient had noticed previously as a first symptom diminution of the sight; meanwhile the ability to distinguish colors diminished. No medication had been given previously except some eyedrops and tonics.

Subjectively, the patient is little disturbed by the nearly total loss of ability of color perception but extremely disturbed by the diminution of sight and the narrowing of the field of vision. It is painstaking for her to move about in the street (continuously she has to turn her head). She has slight but typical complaints of night blindness and is already dazzled by comparatively moderate daylight.

1. Hancock, W. I.: Roy. London Ophth. Hosp. Rec. **16**:496, 1906.
2. Zade, M.: Arch. f. Ophth. **91**:159, 1915; **100**:129, 1919.
3. Gelb, A., and Goldstein, K.: Arch. f. Ophth. **109**:387, 1922.
4. Zentmayer, cited by Peter, L. C.: The Principles and Practice of Perimetry, ed. 2, Philadelphia, Lea & Febiger, 1923, p. 247.
5. Fuchs, A.: Klin. Monatsbl. f. Augenh. **91**:20, 1933.
6. Lillie, W. J., and Adson, A. W.: Arch. f. Ophth. **12**:500, 1934.
7. Krimsky, E.: Am. J. Ophth. **17**:722, 1934.
8. von Schieck, F., and Brückner, A.: Kurzes Handbuch der Ophthalmologie, Berlin, Julius Springer, 1930.

She is always compelled to wear dark glasses on the street. During the last years she has not observed any alteration.

*Physical Examination.*—The only striking feature observed at examination was the masklike face. A complete review of the systems gave negative results; repeated specialistic examinations of the nervous system did not present any significant findings and no symptoms of parkinsonism.

*Ocular Examination.*—In June 1937 the external parts of the eyeballs were normal; the central parts were normal except for a slight cortical peripheral cataract, which could be recognized only in artificial mydriasis. The stroma of the vitreous humor was well designed, scarcely floating and not pathologic. The pupils and background were normal. Neither red nor red-free (green) light gave the faintest symptoms of any alteration of the fundus oculi. The error of refraction was less than 1 diopter. There was a nearly normal objective result of the examination.

The subjective examination, however, showed important defects. Vision in each eye was 2/35 (6 per cent of normal); for near vision Niden's no. 2, 25 test type at a distance of 20 cm. was read very slowly, or rather spelled. The color

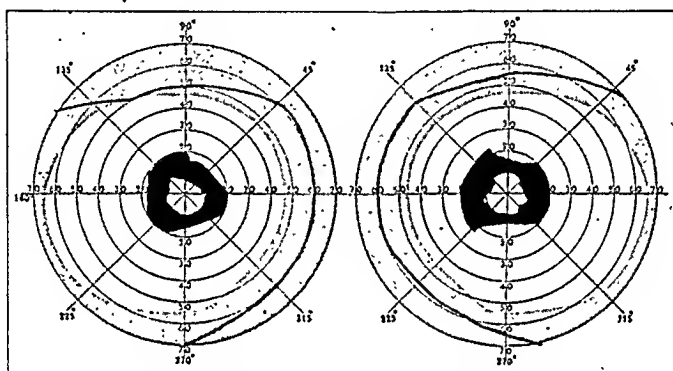


Chart 1.—Visual fields of the patient on July 1, 1937.

sense in the central visual field was limited to large red objects only. The outer margin of the field of vision for white was normal; toward the middle a scotoma was revealed which existed in every sector and began at about 20 degrees and on some parts at 15 degrees (chart 1), the inner boundary being partly near 12 degrees and partly near 8 degrees. Perimetric examination from the middle toward the periphery gave exactly the same results (deviations, if any, no more than 2 degrees). The point in question was an annular scotoma (with some notches) of each eye, reaching from about 20 degrees (outside) to 10 degrees (inside) and giving always the same extension of space, whether the examination was done in artificial illumination or in daylight, in the morning or in the late afternoon.

*Laboratory Examination.*—Urinalysis gave negative results. A specimen of the stool showed hookworms (a common finding in China). The Wassermann and the Kahn reactions of the blood were negative. The spinal fluids according to previous examinations were normal. A roentgenogram of the skull was negative; especially were there no alterations at the sella turcica.

*Mental Status.*—The patient was friendly and cooperative, although not active. Her statements were clear and distinct. No indications for emotional experiential disturbances were observed. Her interests were limited to her own and her family's affairs.

*Course.*—An estrogenic preparation (folliculin menformon), 10,000 mouse units, three times weekly, was given. In addition, a liver preparation (ferripan<sup>9</sup>) was given, by mouth only. When the hormone had to be discontinued for economic reasons, potassium iodine was prescribed, 10 drops of a 50 per cent solution twice daily. No other treatment was given. Altogether 500,000 units of folliculin menformon were administered, but the improvement mentioned subsequently was already noticeable after 200,000 units had been given and did not change after that time.

Objectively, no alterations were seen during the whole period of observation. From the subjective point of view we must mention first a slight improvement which occurred at the outer margin of the scotoma, which still began at some points near 20 degrees as before but had receded at many other points 3 to 5 degrees nearer the center, i. e., near 15 to 18 degrees. The inner limits of the scotoma, however, were exactly the same as before (chart 2). The ability to distinguish colors did not show any improvement. A considerable improvement of the sight was remarkable; it had risen from 2/35 to 5/25 (17 to 20 per cent), three times better than before. For near vision, Nieden's no. 1, 25 test type was slowly read with a + 2.0 sphere. As before, the recognizing of objects in the space (the

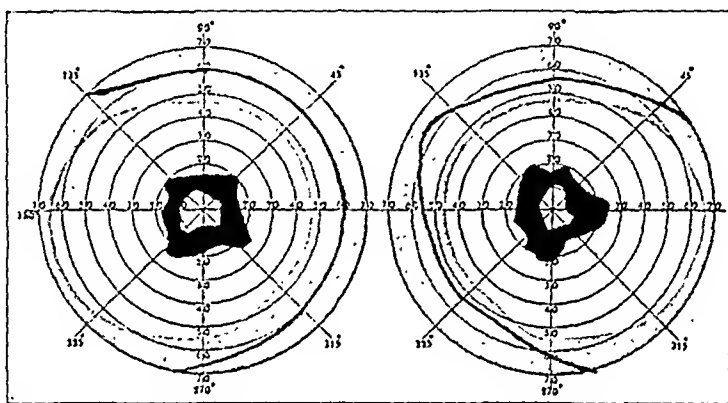


Chart 2.—Visual fields of the patient on May 16, 1938.

patient is more embarrassed by the scotoma than by the diminution of sight) was difficult and evidently little improved. At the time of writing, seven months after finishing the treatment with folliculin menformon, vision and other findings were the same as before.

#### COMMENT

We have had some difficulty in diagnosing the condition in this case and in finding any kind of treatment. As no disturbance of metabolism and no deviation of any organ of the whole body can be detected, we believe that we are entitled to assume that there is a disturbance of the inner secretion, according to the recent theories on pigmentary degeneration of the retina (Wibaut<sup>10</sup> and Meyerbach<sup>11</sup>).

9. Ferripan is a liver preparation which is said to contain, in addition to about 30 per cent albumin, 2.6 per cent iron in the form of an albumoid compound. Compounds of lipoids containing phosphorus and nitrogen together with vitamin D are also present.

10. Wibaut, F.: *Geneesk. bl. u. klin. en lab. v. d. prakt.* **33**:139, 1935.

11. Meyerbach, F.: *Folia ophth. orient.* **1**:317, 1933.

Confronted with the unsatisfactory situation of using a symptom as the term of diagnosis, we are unable to localize this disease definitely. We have to deal with an organic condition of the nervous system, perhaps of the central organ or the peripheral neuron. We have no grounds to suppose that the focus is located in the cortex cerebri (especially, no evidence as to which part of it would be the site) or, even more unlikely, between the tractus opticus and fissura calcarina (Gratiolet's fibers), for we have no indication concerning a traumatic insult in the whole anamnesis and the symptoms have developed extremely slowly. Every interpretation becomes especially difficult by the nearly complete congruency of the defects on the right and left. Even an alteration near the bony surroundings of the tractus opticus, so small that roentgen examination would not reveal it, could never give an explanation of this ring-shaped scotoma of each eye. The fact that we always obtained the same results when changing the conditions of examination entitles us to exclude "factors of fatigability (Gelb and Goldstein<sup>3</sup>): The scotomas were always found in exactly the same place of the field of vision. To suppose that a selected bundle of nerve fibers exists in analogy to the papillomacular bundle which provides an annular zone in correspondence to the scotoma contradicts all our knowledge of anatomic research. Therefore, we are compelled to speak of a "retinitis pigmentosa sine pigmento" as a tentative classification. But it is most striking that this disease, manifestations of which had existed for at least five years, has not resulted in fine alterations of the pigment layer in the periphery (examination with red-free filter). Three items may favor this diagnosis, however. Consanguinity in the patient's family is not certain; nevertheless, all Portuguese families settled in Shanghai are related with one another and show many symptoms of inbreeding. The two other facts are more important: The considerable improvement of sight and the slight improvement of the field of vision after the injections of folliculin menformon. The improvement of sight speaks for success in the treatment of pigmentosa according to Wibaut, who expressed the belief that this disease must perhaps be divided in several different groups. This possibility might be considered also for the ring scotoma, but a further discussion is premature until more observations are collected. Our intention was to stimulate the interest in this field again and to demonstrate that the previous therapeutic nihilism is no longer justified since the introduction of the hormone treatment.

#### SUMMARY

After reviewing in brief the literature of the somewhat neglected problem of ring scotoma, a new case is described. Its remarkable features are the symmetric bilateral symptoms of five years' duration, the ruling out of previously described etiologic factors, the monosymptomatic clinical picture and the marked improvement under treatment with folliculin menformon. A tentative diagnosis of pigmentary degeneration of the retina without pigmentation is discussed.

## Correspondence

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### ANGIOID STREAKS

*To the Editor.*—Dr. Verhoeff has evidently failed to notice that the case of angioid streaks reported in the ARCHIVES in May and June (21: 746 and 935, 1939) was studied in the ophthalmologic, neurologic and pathologic laboratories of the University of Amsterdam (footnote 1, page 746). Only the ophthalmologic study was published in the ARCHIVES. The neurologic study, together with an abstract of the ophthalmologic and pathologic observations, was extensively published in the Dutch language as Dr. Prick's thesis (April 1938). An abbreviated paper in the English language will follow soon. A short summary of both reports together with our final conclusions will be given in the ARCHIVES. In order to prove as soon as possible that Dr. Verhoeff's remarks are obviously unjustifiable, I quote here Dr. Sekir's conclusions given in the English summary of Dr. Prick's thesis:

The postmortal findings (Dr. E. Sekir) showed that in our patient the pathologic changes of the elastic fibers, as known in pseudoxanthoma elasticum, were not only restricted to the skin, but were also seen elsewhere. This holds especially for the abdominal blood vessels.

The mesenterial arteries and their branches in the mucous and submucous membranes of the jejunum, ileum and colon showed a fragmentation of the elastic fibres and a deposit of calcium in and around the diseased fibres. This fragmentation was more especially visible in the internal elastic membrane. The blood vessels of the liver, spleen and pancreas and those of the uterus showed the same abnormalities. In the larger arteries of the kidneys elastic fibres were observed, which were slightly fragmentated. The elastic fibres of the uterine wall and—to a lesser degree—those of the submucous membrane of the small intestine and of the trabecular system of the spleen showed similar pathologic changes.

The ophthalmoscopic diagnosis is, to say the least, doubted by Dr. Verhoeff. If Dr. Verhoeff insists that the diagnosis of angioid streaks requires an appearance such as that seen in figure 2 *A* and *B* of my paper, I am able to understand his letter. However, the streaks may be less typical (figs. 3, 6, 7 and 44). Even Batten's choroidal condition probably is a result of the same disease. The grayish circumpapillary degeneration with a few indistinct streaks or lines, as in figure 7, together with degeneration in the macular region, as in figure 1 (the fundus of a woman aged 48), was best explained by the diagnosis "angioid streaks." The clinical presence of a strongly developed elastic pseudoxanthoma supported the diagnosis, which could be established with certainty after necropsy.

I agree with Dr. Verhoeff that the pathologic picture of angioid streaks resembles that of senile changes, as is evident from my statements on pages 771, 772 (fig. 20) and 963 (2) and from my conclusions on page 964.

It is a fact that in angioid streaks a specific degeneration of the elastic system occurs at a time when other cells and tissues of the body still are in good condition. New formation of elastic tissue is still possible but evidently existing fibers do not reach the age of other tissues. This means a precocious senility of the elastic fibers, which view is supported by the fact that the degeneration occurs especially in regions in which the fibers are subject to continuous change in tension. It is possible that the mechanism which becomes defective in senility may become disturbed in an isolated specific tissue at an earlier age.

There was an important difference, however, in the severity of degeneration and the size and number of the breaks. In the abstract of Dr. Verhoeff and Dr. Sisson's paper in the *Zentralblatt für die gesamte Ophthalmologie* and in the *Annales d'oculistique* and even in the quotations from Dr. Verhoeff and Dr. Grossman's paper only basophilia in senility was discussed, and there was no special mention of breaks in Bruch's layer. The original paper of Dr. Verhoeff and Dr. Sisson was not available in Holland.

It will interest Dr. Verhoeff that in Germany Dr. Böck and his associates quite independently came to exactly the same conclusions (*Ztschr. f. Augenh.* 95: 1, 1938).

A. HAGEDOORN, M.D., Amsterdam, Netherlands.



## News and Notes

EDITED BY W. L. BENEDICT

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### GENERAL NEWS

**Ophthalmic Institute Opened.**—The Ophthalmic Institute of Puerto Rico, established in 1937 by Drs. Luis J. Fernandez-Garcia and Ricardo F. Fernandez in San Juan, recently moved into a new building in Puerta de Tierra, near San Juan. The new institute, built at a cost of about \$70,000, has four floors. On the first are the offices; on the second, private rooms and an operating suite; on the third, wards, and on the fourth, living quarters for the resident staff. In the basement is a dispensary. Dr. Luis J. Fernandez-Garcia, a graduate of the University of Maryland School of Medicine in 1917, is director and chief surgeon, and Dr. Ricardo J. Fernandez, a graduate of George Washington University School of Medicine, Washington, D. C., in 1931, is assistant surgeon.

# Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

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## Congenital Anomalies

CONGENITAL SYMMETRIC ANOMALIES OF THE EYES. A. FAZAKAS, *Klin. Monatsbl. f. Augenh.* 101: 257 (Aug.) 1938.

The author observed a number of congenital anomalies of the lacrimal apparatus, which are described in detail. It is a paramount requirement for the correct function of the lacrimal apparatus that the tear points are located at the most elevated location of its surroundings, namely, at the apex of a triangle formed by the line of the meibomian glands and the upper margin of a fold adjoining the caruncle. Interferences are found in the location of the tear points and canaliculi. The latter may be unusually long, or the lower canaliculus may be bifurcated. Hypertrophy of the frontal process of the maxillary bone produced dislocation of the fossa of the lacrimal sac in some cases. Lateral displacement of the orbits was another cause of lacrimal dysfunction. These and other anomalies are discussed.

K. L. STOLL.

## Cornea and Sclera

THE PATHOLOGY OF SCLERAL PLAQUES: REPORT OF FIVE CASES OF DEGENERATIVE PLAQUES IN THE SCLERA MESIALLY, ONE STUDIED HISTOLOGICALLY. A. M. CULLER, *Brit. J. Ophth.* 23: 44 (Jan.) 1939.

Five cases of scleral plaques are reported, the patients all being over 70 years of age.

There were obvious differences in the clinical picture of these tiny degenerative plaques and scleromalacia perforans. None of the patients suffered from serious arthritis. In none were nodules ever present on the sclera. On the other hand, these lesions have not been described in any location other than between the insertion of the internal rectus muscle and the limbus, whereas the nodules of the early stage of scleromalacia perforans may occur anywhere in the sclera which is covered with conjunctiva. These differences are irreconcilable. One must conclude that recent literature has added two new lesions of the sclera, both primarily degenerative in character.

The author gives the following summary:

"Graves' scleral plaques occur principally in patients over sixty years of age. Approximately 3 mm. behind the corneal limbus mesially, irregularly rectangular translucent plaques in the superficial layers of the sclera may occur. These vary in size from pinpoint to approximately 2 mm. in the horizontal plane, and 6 mm. in the vertical plane, and are usually bilateral. They are slate gray in color because of the ciliary body showing through the area of increased transparency. They do not grossly disturb the neighboring conjunctiva or ciliary body. A distinguishing

characteristic is the definite tendency to square cut borders. To the descriptive name applied by Graves, 'Developmental bilateral mesial superficial intagliated deficiency of the sclera,' can only be added that the histological appearance is that of a degenerative change rather than a developmental defect. No clinical symptoms are known to arise from the lesions. Scleromalacia perforans does not arise in these degenerative plaques in the sclera.

Eight illustrations accompany this article.

W. ZENTMAYER.

#### CLEARING OF LEUKOMA AFTER TRANSPLANTATION OF THE CORNEA.

S. L. WELTER, *Vestnik oftal.* 13: 44, 1938.

Welter reports on 17 of 94 corneal transplantations in which the leukoma cleared about the transplant. The cornea of a cadaver, preserved from seventeen to fifty-one hours after death, was used in all these cases. The histories of the cases are given. In 9 cases simple leukoma was the result of interstitial keratitis; in 8 adherent leukoma formed after ulcers and trauma. The clearing of the leukoma began in from six to eighteen months. In 10 patients there was clearing of the entire surface of the cornea; in the rest from two thirds to one half of the cornea cleared. All transplantations were done by Filatov.

Welter accepts Filatov's explanation for clearing of the leukoma. The products of an autocatalytic process which form in the transplant stimulate the intracellular metabolism in the leukoma, which leads to a regular position of the micellae, a process essential for the transparency of the corneal tissue.

The following conclusions were arrived at:

1. The transplant of the cornea frequently aids in the clearing of the rest of the cornea.

2. The clearing of the leukoma around the transplant is more effective when the cornea of a cadaver is used for the transplant than when the cornea of a living person is used. The process of clearing starts sooner and in some cases the whole surface of the cornea clears. Adherent leukomas respond as well as simple ones.

3. The transplantation of the cornea of a cadaver produces clearing of leukoma of long standing (seventeen to forty-five years).

O. SITCHEVSKA.

#### FILAMENTOUS KERATITIS. L. KRACHMALNIKOV, *Vestnik oftal.* 13: 558, 1938.

The literature on filamentous keratitis is reviewed and a case is reported. A woman, aged 32, suffered from a typical filamentous keratitis, with threadlike secretion and multiple erosions of the cornea in each eye. Tearing was scanty, at times absent. She was operated on four years previously for an extrauterine pregnancy and suffered from a chronic oophoritis. Krachmalnikov believes that this type of keratitis is associated with disturbance of the function of the endocrine system. This would explain the fact that it occurs more frequently in women than in men and at the menopause.

O. SITCHEVSKA.

A CASE OF AMOTIO RETINAE ATTENDING SCLERITIS. STEFFEN LUND, *Acta ophth.* 16: 414, 1938.

Detachment of the retina as a complication of scleritis occurs infrequently. The author records such an instance. In a woman who had been the subject of repeated attacks of scleritis, typical retinal detachment developed during the course of a particularly severe recurrence. After a scleral abscess formed and ruptured, the retina gradually became entirely adherent, only slight pigmentary changes marking the site of the detachment.

Reattachment also occurred in 4 of the 5 recorded cases which the author cites.

O. P. PERKINS.

### Experimental Pathology

TOLERANCE TO INOXIDIZABLE STEEL IN THE RABBIT'S EYE. M.-A. DOLLFUS and I. BORSOTTI, *Bull. Soc. d'ophth. de Paris* 50: 422 (Oct.) 1938.

In a previous report the authors related some experiments in which the introduction of inoxidizable steel into rabbit's eyes did not cause any reaction. At that time the question was asked concerning the ultimate result after the steel had been in the eye for long periods. The purpose of the present report is to answer this question. Rabbit 2 was killed after two hundred and forty-five days in order to make a histologic study. Hyphema was present for two days after the fragment of steel was introduced, but by the thirteenth day the eye was perfectly quiet. The particle showed no signs of oxidation while lying in the anterior chamber. There were no signs of siderosis. Stainless steel introduced into the lens showed no reaction except for a slight opacity of the lens after two hundred and thirty-one days. Chemical tests with potassium ferrocyanide showed no reaction. The authors conclude that inoxidizable steel as used in modern industry is much safer as far as injury to the eye is concerned.

L. L. MAYER.

GLYCOLYSIS AND RESPIRATION OF THE LENS IN NAPHTHALENE CATARACT. A. FERRARA, *Ann. di ottal. e clin. ocul.* 66: 862 (Nov.) 1938.

The author reviews the literature on naphthalene cataract, especially recent work relating to sugar and calcium metabolism in naphthalene poisoning. The claim of Michail and Vancea that hyperglycemia is due to lesions of the pancreas was refuted by subsequent observers, who found a great variation in the blood sugar of normal animals. The idea that a low blood calcium may be a factor has, however, received some support. Employing the Warburg technic on the lenses of normal and naphthalinized animals, the author found that in partial cataract oxygen consumption was not affected, while anaerobic glycolysis was markedly reduced. In total cataract the latter function and also oxygen consumption were abolished. He believes the loss of glycolysis may be responsible for opacification of the lens, while accumulation of calcium in the lens, a phenomenon which accompanies a low blood calcium, may be a factor in reducing the glycolytic power of the lens.

S. R. GIFFORD.

EXPERIMENTAL RESEARCH ON THE ACTION OF SHORT WAVE RAYS  
ON THE NORMAL AND INFECTED EYE OF RABBITS. H. SCHEYHING,  
*Klin. Monatsbl. f. Augenh.* 101: 327 (Sept.) 1938.

Experiments with short wave rays on healthy and infected eyes of rabbits have yielded some definite results. No lesion on normal eyes was observed either directly or belatedly after exposure to short wave rays up to a thermic tension of 17.5 units. Higher thermic tension may cause transient corneal opacities or permanent severe burns of the lids. Corneal ulcers produced experimentally with staphylococci were influenced favorably by these rays if they were applied in the manner described. The ulcers healed more promptly than under other forms of therapy, leaving only faint scars. Experimentally produced epithelial herpes of the cornea healed after a few irradiations, whereas it progressed into the deeper layers of the cornea in animals equally infected but not treated with short wave irradiation. Purulent processes induced by inoculation of the anterior chamber with staphylococci healed promptly after irradiation, while pupillary hulls resulted or the purulent process extended into the cornea, with final sloughing, in those animals which received no irradiation. Staphylococcic abscesses produced in the vitreous remained uninfluenced.

Scheyhing's experimental results tallied with his clinical results with short wave rays in cases of abscess of the lid, phlegmons of the lacrimal sac, advanced serpent ulcers, epithelial forms of herpes of the cornea, superficial punctate keratitis and exudative rheumatic iritis. Best results were obtained in cases of acute involvement. No results were observed clinically in any other part of the eye but the cornea, anterior chamber and iris, aside from the lids and tear sac. It remains uncertain whether the dose of the short wave rays may be increased sufficiently so as to influence purulent conditions of the vitreous, ciliary body, retina, choroid and optic nerve.

K. L. STOLL.

### General Diseases

SYNDROME OF MARFAN. J. S. CHARAMIS, *Arch. d'opht.* 1: 1067 (Dec.) 1937.

The syndrome of Marfan has been known to pediatricians for forty years according to the author, but the ophthalmic aspects have received attention only since 1926. One hundred and thirty-one cases have been reported in the literature, including the case cited in detail in this presentation. The syndrome can be included in the large group of ocular conditions occurring in association with dystrophies of the bones. In several instances the ophthalmologist has been the first to make the diagnosis because of visual defects. The author's case is presented in full detail with photographs of the patient and roentgenograms of the whole skeleton. The three main theories to explain the pathogenesis are cited. In the author's opinion the most satisfactory theory considers this condition as the result of a dystrophic hypersecretion of the anterior lobe of the pituitary body, acting through an intrarachidian path and producing an intrauterine gigantism. Few patients have been observed for any length of time. During the five year period of observa-

tion of the patient whose case is described here, the author noted the increase in the size of the globe and the cornea, the rapid development of cataract, especially in the right eye, and the increase in myopia. Organic changes in the heart, peribronchial lymph nodes, delayed puberty, defective muscular system and the absence of permanent fatty tissue were recorded. Changes in the skeleton were likewise observed. General treatment is of no avail. Operation is indicated for the removal of cataract and because of the high myopia, which is progressive.

S. B. MARLOW.

### Glaucoma

STUDIES ON SYSTEMIC CAUSES OF GLAUCOMA. H. SCHMELZER, Arch. f. Ophth. 139: 465 (Nov.) 1938.

In search of systemic causes of glaucoma Schmelter studied the blood chemistry of 55 persons with primary glaucoma and of 45 controls who were inpatients at an ophthalmic clinic and of approximately the same ages as the patients with glaucoma. There were many persons in the control group who had senile cataract. Quantitative determinations, once for each patient, were made of the following substances: bilirubin, uric acid, dextrose, cholesterol, indican and substances containing the phenyl group (xanthoproteic reaction). High values for cholesterol, exceeding 200 mg. per hundred cubic centimeters in 94 per cent of the cases, and for the xanthoproteic reaction seemed to be characteristic of the cases of glaucoma. The author interprets these findings as signs of a hepatic disorder and recommends a diet low in fats and protein and abstinence from alcohol, nicotine and caffeine as therapeutic adjuncts to the usual local treatment. P. C. KRONFELD.

THE CONSTITUTION OF PATIENTS WITH GLAUCOMA. L. NEMETH, Klin. Monatsbl. f. Augenh. 101: 222 (Aug.) 1938.

The author refers to the change of the terminology of dyscrasia to constitutional condition, cites the research of a number of authors in this field and describes his own methods of examination and classification of the patients. He accepts Kretschmer's division in pyknic, asthenic and athletic types and the mixed types derived therefrom. The routine of the measurements of the body is described. Especial consideration was given the shape of the skull and the influence of sex on the physical constitution. Fifty male patients with primary glaucoma were examined at the ophthalmic clinic in Budapest and an equal number in Berlin. The types of their constitutions were recorded. In most of them the course of the disease could be followed for a number of years. No type was found to be predestined to primary glaucoma, whereas the type of the glaucoma depended on the patient's constitutional type: Inflammatory glaucoma prevailed among the asthenic type. Glaucoma develops sooner in the asthenic type than in other types, but it is less influenced and progresses more rapidly in asthenic than in pyknic patients, while the blood pressure of the asthenic patients with glaucoma was usually the lowest. The climatic difference between Berlin and Budapest gave rise to observations to

the effect that climatic fluctuations may render the therapeutic effect on glaucomatous attacks more difficult. The individual constitution of the patient must influence the therapy. Asthenic patients require proper quieting of the nervous system, whereas in pyknic patients treatment of the vascular system is of great importance, so as to prevent an acute glaucomatous attack.

K. L. STOLL.

### Injuries

TRAUMATIC LESIONS OF THE IRIS. J. MALBRAN, Arch. de oftal. de Buenos Aires 13: 431 (Aug.) 1938.

Two cases of traumatic lesions of the iris are reported. The lesion in 1 case was partial disappearance of the iris, which is rare; that in the other case consisted of total irideremia, with disappearance of the lens, following contusion of the eyeball without perforation or rupture of the ocular coats.

The literature on similar lesions is reviewed.

C. E. FINLAY.

PENETRATING WOUNDS OF THE CILIARY BODY: REPORT OF CASES. E. OLÁH, Klin. Monatsbl. f. Augenh. 100: 905 (June) 1938.

Wagenmann and Blaskovics disagreed as to the dogma that every lesion, or laceration, of the ciliary body presents necessarily a danger. Oláh describes 2 cases of penetrating stab wounds of the ciliary body. He freed the adherent portion of the ciliary body in the first case, that of a boy aged 13 years. Describing the operative technic, Oláh refers especially to the grasping of the ciliary body, the only difficulty met with, in his opinion. The irritation disappeared after the operative procedure, and vision returned. In the second case a fine penetrating wound could be detected only after disappearance of the primary ciliary injection. No operation was performed on this patient's eye. The eye was removed as dangerous to its mate when precipitates on Descemet's membrane and the other symptoms were still present after two months. The author concludes that no danger arises from penetrating wounds of the ciliary body with impactions if the latter are removed as soon as possible and if no infection intervenes. The eye is doomed when the impactions are not freed.

K. L. STOLL.

OPERATIVE TREATMENT OF TRAUMATIC IRIDODIALYSIS: REPORT OF A CASE. R. THIEL, Klin. Monatsbl. f. Augenh. 100: 918 (June) 1938.

A boy, aged 15 years, was examined fifteen minutes after being struck in the left eye with a nail. Aside from a tear of the cornea along the corneoscleral margin, iridodialysis was observed, measuring about 3 mm. The sclera and the sphincter of the iris were intact. An incision 3 mm. in length, 1 mm. outside the limbus, was made, and an attempt to replace the torn portion of the iris with a blunt iris hook was unsuccessful. Thiel succeeded in replacing the iris with an iris forceps inside the corneal wound, in which it remained fastened. The pupil was fairly round after the operation. Only a small gap about 1 mm. in length

was noted with the slit lamp; restitution of the iridocorneal angle was obtained, and vision was normal after an uneventful recovery. Golovin's subconjunctival incarceration of the iris may have to be resorted to in cases of extensive iridodialysis; cauterization for subconjunctival prolapse of the iris must follow, so as to avoid later infection. If the iridodialysis is extensive several incisions near the limbus may be necessary, and occasionally the operation will have to be done at two sittings.

K. L. STOLL.

### Lacrimal Apparatus

EXTENSION OF A MUCOCELE INTO THE LACRIMAL SAC. A. TRISCORNIA, B. JUST and C. MERCANDINO, Arch. de oftal. de Buenos Aires 13: 485 (Sept.) 1938.

The authors report a case of mucocele extending into the lacrimal sac as a rare lesion. A brief consideration of the usual nature and evolution of mucocele, with bibliographic references, is given.

C. E. FINLAY.

CHRONIC BILATERAL DACRYOADENITIS. M. RABINOWITCH, Vestnik oftal. 13: 112, 1938.

A case of bilateral chronic dacryoadenitis in a young female is reported. Ptosis on the temporal side, a moderate internal strabismus and absence of lacrimation were observed. Slight enlargement of the thyroid gland was found on general examination. The extirpated tumors showed degenerated lacrimal gland tissue. Rabinowitch suggests that there might be some connection between the enlargement of the thyroid and the inflammatory process in the lacrimal gland.

O. SITCHEVSKA.

DACRYOCYSTITIS IN CHILDREN, WITH PARTICULAR REFERENCE TO NEGLECTED CONGENITAL STENOSIS OF THE NASOLACRIMAL DUCT. K. O. GRANSTRÖM, Acta ophth. 16: 512, 1938.

Of 28 cases of dacryocystitis in children from 1 to 15 years of age, the cause in 9 was probably a neglected congenital stenosis of the nasolacrimal duct.

O. P. PERKINS.

### Lens

DERMATOGENOUS CATARACT. A. WINKLER, Arch. f. Ophth. 139: 526 (Nov.) 1938.

To the many reported cases of cataract in young adults accompanied by cutaneous manifestations, such as eczema or neurodermatitis (Daniel, R. K.: *Tr. Sect. Ophth., A. M. A.*, 1935, p. 50), the author adds a case of his own. A man, aged 27, had been suffering from pruriginous eczema off and on since the age of 4. Since reaching the age of 18 he had never been free from eczema. Both lenses were cataractous (vision in the right eye, perception of light; vision in the left eye, 6/18) and showed, in addition to nuclear and cortical opacities, the subcapsular,



anteriopolar, shield-shaped opacities characteristic of cataract associated with eczema. Examination by the internist revealed abnormally high values for indican, tryptophan and phenolic substances in the urine. A disorder of the gastrointestinal tract could be ruled out. The urinary findings were interpreted as signs of an abnormal protein metabolism. The hepatic function was not impaired. The possibility of the eczema being a manifestation of allergy was apparently not considered.

P. C. KRONFELD.

CLINICAL AND HISTOLOGIC STUDIES ON SENILE EXFOLIATION OF THE ANTERIOR LENS CAPSULE. W. WIEDERKEHR, *Arch. f. Ophth.* 139: 541 (Nov.) 1938.

The author reports 14 cases of senile exfoliation of the anterior lens capsule (Vogt) in which the condition was diagnosed in vivo. The patients were inmates of old peoples' homes. Five presented evidence of glaucoma (glaucoma capsulare, Vogt). The eyes of all 14 persons became available for histologic examination. Their lenses were embedded in paraffin. The primary change is apparently the development of vacuoles in the lens capsule, which push the lamellae of the capsule apart. Parts of the thus loosened lamellae may be brushed off by the iris and become lodged on the posterior surface of the iris, on the pupillary border or even on the posterior surface of the cornea. Since these capsular fragments are extremely resistant to enzymes, they are likely to block the channels of exit of the aqueous. Only the anterior lens capsule undergoes exfoliation. The lens epithelium is usually well preserved. Since exfoliation of the lens capsule occurs only in elderly persons, one often finds it combined with senile cataract, but there is no causal relation between the two diseases.

P. C. KRONFELD.

TIME FACTOR IN THE OCCURRENCE OF LENTICULAR OPACITIES AFTER IRRADIATION WITH RAYS OF VARIOUS WAVELENGTHS. E. WÖLFFLIN, *Klin. Monatsbl. f. Augenh.* 101: 321 (Sept.) 1938.

It is known that one or more irradiations with divers wavelengths, ranging from infra-red to radium rays, may produce opacities of the lens. A similar effect has not been experimentally proved for the ultra short waves. The times elapsing between irradiation and the production of degenerative lesions of the lens are diametrically proportionate to the wavelengths; lesions may occur after irradiation with infra-red rays within a few hours, after irradiation with ultraviolet rays after a few days and after irradiation with short wave roentgen or radium rays after a few months or years. The changes are not produced by a direct lesion on the lens or its epithelium but by indirect influences acting by way of the ciliary body, the nourishing organ of the lens. Discussing the research and views of other authors and his own, Wölfflin concludes that the appearance of lenticular opacities after irradiation with rays of different wavelength after varying periods is not a uniform process which may be explained by a purely physical action. Otherwise it would be difficult to explain physiologically the unusually long time elapsing before the appearance of opacities after roentgen irradiation; it would be difficult to understand, furthermore, why the

posterior layers of the lens should be the first to become opaque. Comparable with this process is that leading to belated corneal opacities after poisoning with yellow cross gas (dichlorethyl sulfide). The primary location of this chemical lesion, probably, is the net of marginal vessels of the cornea.

K. L. STOLL.

### Lids

CYSTS OF THE MARGIN OF THE EYELID. A. HAGEDOORN, *Am. J. Ophth.* 21: 487 (May) 1938.

Hagedoorn discusses the various cysts affecting the margins of the eyelid and gives the following summary:

"Cysts of the margin of the eyelid may originate from congenitally malformed areas and from both sweat-gland and sebaceous-gland elements. A case is reported in which a cyst of the eyelid occurred simultaneously with a syringoma of the skin. A second case which could be studied microscopically showed that the cyst developed from an area which contained anomalies of the epithelium, hair follicles, sweat glands, and sebaceous glands."

W. S. REESE.

### Methods of Examination

ROENTGEN LOCALIZATION OF INTRAOCULAR FOREIGN BODIES BY MEANS OF IODIZED POPPYSEED OIL. BARRAT, *Arch. d'opht.* 1:605 (July) 1937.

The method proposed by Barrat consists essentially in the subconjunctival injection of iodized poppyseed oil close to the limbus. The vertical diameter of the cornea is measured with dividers. A lateral and a front view are then taken with lids closed or the eye bandaged.

S. B. MARLOW.

EXPLORATION OF THE CORNEA BY TRANSILLUMINATION. TRANTAS, *Arch. d'opht.* 1: 881 (Oct.) 1937.

Trantas reviews what he has previously written on this subject. He believes transillumination to be neglected and points out the simplicity of its use, especially when done through the lid. Done in this way, no anesthetic is necessary to avoid discomfort to the patient. The use of slit lamp illumination is also described. The author discusses the various conditions of the cornea which can be detected by this procedure. He states that many times conditions will be discovered which escape direct observation with the biomicroscope.

S. B. MARLOW.

### Neurology

ESSENTIAL NEURALGIA OF THE FACIAL NERVE. CARLOS CHIARLIN, *Ann. d'ocul.* 175: 894 (Dec.) 1938.

Persistent neuralgia of the facial nerve of unknown cause which is resistant to all treatment lasts for many years and sometimes for a life-

time. Such neuralgia is frequent. The authors state that the cause is unknown, because both etiologic research and symptomatic therapeutics have been without avail. Most patients with this type of neuralgia are submitted time and again to antisyphilitic treatment, to protein therapy of many kinds, to removal of teeth and to nasal operations without relief. Neurologic investigation generally shows idiopathic neuralgia to be one of five types: (a) essential neuralgia of Sicard, (b) sympathetic neuralgia, (c) cyclic neuralgia, (d) causal neuralgia, and (e) secondary neuralgia. The cause of the last type is also unknown.

A summary is made of observations on the first 50 patients. All of them were given neurologic, medical, ophthalmic, otorhinolaryngologic, dental and phthisiologic examinations before treatment was started. Of this series, 18 had a tuberculous history. Tuberculous lesions were found at the site of the neuralgia in 10, and 31 had thoracic bacillary lesions, in 5 of whom they were clinically active. Improvement was noted in all these patients after tuberculin therapy, bacteriologic treatment and specific therapy.

S. H. McKEE.

OCULAR SYMPTOMS IN EPIPHARYNGEAL TUMORS: REPORT OF CASES.  
E. CUSTODIS, *Klin. Monatsbl. f. Augenh.* 101: 49 (July) 1938.

In an introduction Custodis explains the importance of tumors of the epipharynx by the proximity of this organ to the base of the skull and the sphenoid bone. The observation of 4 cases prompts the author to draw the following conclusions: Benign as well as malignant tumors of the epipharynx may produce disturbances of the sensory, motor and sympathetic nerve fibers connected with the eye. While the malignant neoplasms of the epipharynx may be characterized by a certain complex of symptoms, the benign tumors manifest themselves in various clinical forms. Unexplained disturbances of the eyes and of the nerves supplying the orbit should prompt an examination of the epipharynx by the rhinologist. Roentgenographic examination may facilitate the diagnosis. The characteristic changes produced by a tumor of the epipharynx can be recognized in the axial view of the base of the skull and on antero-posterior exposure of the skull.

K. L. STOLL.

THE IMPORTANCE OF OCULAR SYMPTOMS IN LOCALIZATION OF TUMORS OF THE BRAIN. H. OLIVECRONA, *Acta ophth.* 16: 431, 1938.

This article concerns the effects of tumors of the brain on (1) the situation and shape of the eyeball, (2) the motility of the eyeball and (3) the visual pathway.

Exophthalmos, the important symptom of the first group, may be the result of meningioma of the lesser wing of the sphenoid bone as well as of osteoma of the frontal or sphenoid sinuses. The syndrome of the superior orbital fissure as produced by aneurysms of the carotid artery is described, but it is rarely the result of tumor. Enophthalmos is not caused by tumor. Buphthalmos occurring in the presence of intracranial symptoms indicates Sturge-Weber's disease.

Disturbance in ocular motility are considered at length. Glioma of the medial, anterior portion of the temporal lobe may produce increased intracranial pressure, hallucinations of taste or smell, homolateral oph-

thalmoplegia and homonymous (usually upper quadrant) hemianopia. A similar syndrome is found in cases of meningioma of the middle fossa, but here ophthalmoplegia is less likely.

Supranuclear conjugate paralysis is a valuable localizing sign. It may be of lateral or of vertical movements. Dissociated paralysis (i. e., with reflex motility retained) of lateral movements is almost never caused by a tumor of the brain, whereas complete paralysis may be caused by an intrapontile or extrapontile tumor. Similarly, dissociated paralysis of vertical movements is rarely caused by tumor, but complete paralysis is found in association with tumor of the quadrigeminal plate and as a result of tumor in the roof of the fourth ventricle.

Under the third heading is considered the chiasmic syndrome as brought about by adenoma of the pituitary gland, meningioma, cranio-pharyngioma, chiasmal glioma, cholesteatoma, hydrocephalus and arachnoiditis.

The clinical and roentgen findings in these conditions are given.

The syndrome of Foster Kennedy is the important prechiasmic syndrome.

Posterior to the chiasm, hemianopias of the optic tract are rarely produced by tumors, whereas interruption of the optic radiations by tumor is frequent. Some observations are made concerning these defects of the visual field.

The fundus is dismissed with the observation that the finding of a retinal angioma in the presence of a tumor syndrome indicates a cerebellar angioma.

O. P. PERKINS.

THE FOCAL DIAGNOSTIC OF THE VISUAL PATH. H. RØNNE, *Acta ophth.* 16: 446, 1938.

Rønne deals with the defects of the visual field produced by lesions at the various levels of the optic pathway. The orbital portion of the optic nerve is dismissed with the observation that glaucoma interrupts the visual fibers at the border of the papilla and that atrophy of the tabetic type also attacks the optic nerve fibers and not the ganglion cells of the retina. Involvement of the intracranial portion occurs in meningiomas of the olfactory groove, causing Foster Kennedy's syndrome. Thrombosis of the internal carotid artery near the origin of the ophthalmic artery gives rise to the carotid syndrome—homolateral blindness with the picture of embolism of the central retinal artery, contralateral hemiplegia and eventually incomplete aphasia.

In cases of lesions of the anterior angle of the chiasm a hemianopic central scotoma is likely to be overlooked. In cases of tumors of the pituitary gland bitemporal central scotoma is a fairly common initial lesion. The peripheral defects occur first in the upper temporal fields, then, in order, in the lower temporal fields, the lower nasal quadrants and the upper nasal quadrants. However, deviations are common.

While the differential diagnosis between hemianopia of the optic tract and retrogenicular hemianopia is theoretically easy it may not be so practically. In the lesion of the optic tract there should be visible atrophy of the optic nerves and a hemianopic pupillary reaction. Anisocoria is

present, the wide pupil being on the side of the hemianopia. The author believes macular sparing to be more frequent in cases of hemispheric hemianopia than in cases of hemianopia of the optic tract.

Quadrantic hemianopias are important in cases of lesions between the geniculate body and the cortex. Rønne believes the macular fibers anatomically separate the fibers of the two nasal quadrants of the visual field and that the fibers of the crossed bundle pattern themselves similarly.

Homonymous hemianopic central scotomas are rare. They may occur in cases of multiple sclerosis of the optic tract, but they occur more often in cases of cortical lesions at the apex of an occipital lobe.

Hallucinations and photopsias in the hemianopic half of the visual field indicate cortical lesions with irritation of fibers from the visual centers to the higher associated centers.

O. P. PERKINS.

### Ocular Muscles

DISTURBANCE OF THE ASSOCIATED MOVEMENTS OF THE EYES. E.

ADROGUE, Arch. de oftal. de Buenos Aires 13:408 (Aug.) 1938.

The author refers to the different modalities of associated movements of the eyes secondary to cortical and noncortical reflexes and to the cortical centers considered by different authors as presiding over them, the connection between them and the basal motor nuclei being as yet unknown, although the importance of the posterior longitudinal bundle is generally admitted. The author agrees with Morax that there is no conclusive evidence in favor of the existence of supranuclear coordinating centers.

The disturbances of the associated movements due to paralysis of the conjugate movements and to disturbances of the same due to excitation are studied clinically. As regards the former, the author distinguishes conjugate deviation due to cortical and pontile lesions, paralysis of the vertical movements of the eyes and paralysis due to internuclear lesions from paralysis of the associated movements. The Hertwig-Megendie type produced by vestibular lesions is described, and finally the different varieties of nystagmus are analyzed. All the descriptions are exemplified by personal cases.

C. E. FINLAY.

FAMILIAL PTOSIS AND OPHTHALMOPLÉGIA OF THE SUPRANUCLEAR TYPE: REPORT OF CASES. J. SCHARF, Klin. Monatsbl. f. Augenh. 101:71 (July) 1938.

Congenital ptosis with or without ophthalmoplegia has been reported by several authors, and Bielschowsky proved that paralysis of fixation as a congenital anomaly was of supranuclear origin. Scharf reports on 3 of 5 children of the same generation in a family with congenital ptosis and incomplete paralysis of fixation. Their ocular symptoms correlated completely, and the supranuclear location of the lesion was evident. The 2 sisters were 25 and 39 years of age, respectively, and the brother was 29. Bell's phenomenon was present in each of them. The sisters presented myopic astigmatism, and the brother, emmetropia. The function of the ocular muscles is described and discussed in detail

in connection with the innervation, and a résumé of allied theories is given. Satisfactory results were obtained with the operation for ptosis after the method of Hess and Elschnig, as illustrated by pictures.

K. L. STOLL.

VARIATIONS OF STRABISMUS AND OTHER OCULAR DIVERSITIES IN MONOZYGOTIC TWINS: REPORT OF A CASE. G. JANCKE, Klin. Monatsbl. f. Augenh. 101:76 (July) 1938.

The relatives of a pair of female monozygotic twins born in November 1936 observed transient strabismus, alternating with periods of several weeks in which no strabismus was noticed. Squint was allegedly never observed in any member of the family. The right eye of each twin was the leading eye and had normal vision, while the vision in the left eye of one twin was reduced to 5/15 of the normal and that in the left eye of the other twin was reduced 5/7.5. After reporting on his findings and citing the literature in point, Jancke draws the following conclusions: The fundi of the twins showed concordance, except for medullary fibers in one eye of one twin. The fusion was discordant during observation, with possible undulations of fusion; hereditary lability of fusion of a low degree was present. One of the twins presented an absence of binocular and stereoscopic vision. Discordance of the position of the eyes manifested itself, as one twin was spontaneously able to overcome convergent strabismus, whereas the other showed continued divergence. Amblyopia of a minor degree did not cause permanent strabismus in one twin in the presence of normal fusion. Jancke thinks that strabismus may alternate between convergence and divergence in the same person.

K. L. STOLL.

### Operations

A NOTE ON THE USE OF HORSE HAIR SUTURES FOR THE CONJUNCTIVA. P. J. HAY, Brit. J. Ophth. 23:43 (Jan.) 1939.

Hay found horsehair sutures extremely useful in a Frost-Lang operation for closing the wound after insertion of the glass globe. A horsehair suture on a Mersuture needle is passed from below upward, then in and out along the lips of the wound, about 2 or 3 mm. from the margin; finally it is passed down and out beyond the other end of the wound. The suture is then drawn taut, and a loop is made at each end and so placed as to lie outside the lids when the eye is closed. A horsehair suture keeps the wound firmly closed because of its rigidity, and yet it does not bunch the conjunctiva as does a silk purse-string suture. The same kind of a suture may be used with advantage for closing the wound in the conjunctiva after trephining.

W. ZENTMAYER.

SURGICAL TREATMENT OF TRAUMATIC IRIDODIALYSIS: REPORT OF CASES. Z. NIŽETIĆ, Klin. Monatsbl. f. Augenh. 100:900 (June) 1938.

Nižetić reports replacement in 2 cases of traumatic iridodialysis by incarceration of the detached portion of the iris into an incision of the

cornea. In describing his method the author refers to a similar case, published two years ago. This method, resembling Holth's iridencleisis, has been performed in various ways by other operators. Nižetić forms a large conjunctival flap and makes a corneotomy opening scleralward from the iridocorneal angle and horizontal with the iris. In a second operation the subconjunctival remnant of the iris is cauterized. Baslini inserts two sutures at the extremities of the incision, calling his operation *iridopexsis* (iridopexy).

K. L. STOLL.

### Orbit, Eyeball and Accessory Sinuses

PAROXYSMAL ALLERGIC EDEMA OF THE GLOBE: ITS RELATION TO INTERMITTENT EDEMA OF THE CORNEA. L. WEEKERS, Arch. d'opht. 1: 769 (Sept.) 1937.

In this study Weekers attempts to define an ocular malady in which the lesions are essentially an angioneurotic edema of a part or the whole of the uvea and possibly also of the retina. This condition, paroxysmal allergic edema of the eye, groups several ocular disorders different in appearance but actually similar in nature and representing diverse expressions of a disease the seriousness of which varies markedly. The author refers to a case of iritis reported by Roche and a case of opacities of the vitreous cited by Foster Kennedy. He discusses those rare cases of intermittent edema of the cornea which have been reported in the literature. He points out the similarity of these cases to those of angioneurotic edema and the physical characteristics common to all.

S. B. MARLOW.

ALLERGICALLY CONDITIONED CHANGES IN THE INTRAOCULAR PRESSURE. H. SJÖGREN, Acta ophth. 16: 542, 1938.

This report concerns a 34 year old carpenter in whom, after contact with certain kinds of wood, unilateral or bilateral nasal obstruction develops, together with unilateral or bilateral edema of the eyelids, conjunctival chemosis, transitory myopia, shallowness of the anterior chamber and considerable diminution of intraocular pressure. The attacks last about eighteen days, improvement beginning after ten days.

The author believes it not unlikely that some conditions which have been described as transitory myopia or essential hypotony were of an analogous, that is, allergic, nature.

O. P. PERKINS.

### Refraction and Accommodation

HIGH UNILATERAL MYOPIA WITH STRABISMUS: EXTRACTION OF TRANSPARENT LENS. L. PAUFIQUE, Bull. Soc. d'opht. de Paris 50: 476 (Oct.) 1938.

A girl aged 17 years was given the following correction: For the right eye, a — 1.50 cylinder, axis 160; for the left eye, a — 18.00 sphere. The visual acuity of the right eye was 8/10 and that of the left eye 1/10. The right eye diverged 20 degrees. The fundus of the right eye was normal. The left eye showed a large posterior staphyloma,

but the choroid and macula were normal. Simple extraction of the left lens was done, and at the same time a hole was made in the center of the posterior capsule. The cosmetic result was excellent, with vision of 2/10 recorded for the aphacic eye. Paufigue advises discission and aspiration of the lens between the ages of 10 and 25; after 25, he advocates total extraction and the use of corneal sutures. The value of such a procedure to correct strabismus without operation on the muscles is stressed by Paufigue.

L. L. MAYER.

STRUCTURE OF THE BODY AND REFRACTION. E. FRANCKE, *Klin. Monatsbl. f. Augenh.* 101: 184 (Aug.) 1938.

In a detailed article, well illustrated with statistics and tables, Francke reports on measurements of the structure and growth of the body and skull with reference to refraction. Numerous related data are given, such as those pertaining to heredity, prominence of the eyeball and pupillary distance. About 500 persons with emmetropic, myopic and hypermetropic eyes were examined relative to the structure and growth of their bodies. The myopic persons were predominantly of the tall, leptosome type, whereas the broad, pyknic type prevailed among the hyperopic persons; the former were 3.30 cm. taller than the latter as an average. The cranial index of the hyperopic persons was slightly higher than that of myopic persons. Stature and breadth of the body differed also in myopic and hyperopic persons in relation to age, more evidently in men than in women. Among persons with high degrees of myopia, small, pyknic and even dysplastic types were found. Hence, two types of myopia seem to exist: first, the so-called myopia of growth, usually of a moderate degree, which develops during school years, mostly in slender and tall persons; and second, the deletory form of myopia, which is found more frequently in association with small and dysplastic bodily structure.

K. L. STOLL.

### Retina and Optic Nerve

PROTEOLYTIC FERMENTS OF THE SUBRETINAL FLUID: CLINICAL VALUE IN DETACHMENT. H. J. M. WEVE and F. P. FISCHER, *Ann. d'ocul.* 174: 807 (Nov.) 1938.

In a previous communication on this subject the authors called attention to the clinical importance of their observations and gave the histories of 3 patients. The subretinal fluid of 2 contained a large amount of ferment, and repair was difficult to obtain; the subretinal fluid of the third patient presented characteristics directly opposite.

The authors continued their observations, studying 97 detachments with tears and 7 other detachments. The technic is described, the results are classified and discussed and the following conclusions are drawn:

1. In 87 per cent of cases of detachment of the retina the subretinal fluid practically never destroyed the fibrin.

2. Proteolysis of the subretinal fluid is increased in cases of recent detachment, in cases of complicated detachment and in cases of disinsertion with cysts.



3. Increased proteolysis is incompatible with the formation of rigid folds in the form of stars (provided the operative procedure is suitable).

4. There is no real definite relation between the destruction of fibrin and the prognosis of the operative result.

5. The operative result will be favorable if the proteolysis of the vitreous is normal, that is to say, just sufficient to prevent the formation of folds when the retroretinal fibrin is not attacked and contributes to the union between the retina and the choroid.

S. H. McKEE.

IMPORTANCE OF  $p_H$  FOR THE PROTEOLYTIC ACTIVITY OF SUBRETINAL FLUID AND ITS INHIBITION. H. J. M. WEVE and F. P. FISCHER, *Ann. d'ocul.* 174: 813 (Nov.) 1938.

The authors have already pointed out the influence of  $p_H$  on the activity of proteolytic ferment. The difference observed was not great but was easily measured. On the other hand, the effect of  $p_H$  on the inhibition of proteolysis was definite; this restraint is due to the retina. Between a  $p_H$  of 8 and 6.5 the inhibition increases with a lowering of the  $p_H$ ; beyond 6.5 there is an inhibition with increasing acidity. Under the circumstances the authors questioned whether the differences in proteolysis were not related to the differences in  $p_H$ . They have examined the  $p_H$  of the subretinal fluid of more than 80 persons, and they describe the technic of their examination in detail and report the results obtained. Their conclusions follow:

1. The  $p_H$  of the subretinal fluid is lowered with duration of the detachment.

2. There is no relation between the proteolytic capacity of subretinal fluid and its  $p_H$ .

3. There is a definite relation between the inhibition of proteolysis and the  $p_H$ . It is augmented with the lowering of the  $p_H$ .

4. In detachments of long standing lowering of the  $p_H$  and its restraint are important to the proteolysis when there is a tendency to rigid folds.

S. H. McKEE.

LOCAL TREATMENT OF VASCULAR DISEASES OF THE FUNDUS. P. BAILLIART, *Bull. Soc. d'opht. de Paris* 50: 451 (Oct.) 1938.

General treatment should be the first considered in cases of vascular diseases of the fundus. The local use of pomades and collyria has become a habit with most ophthalmologists. Ionization, diathermy and various forms of rest must not be lost sight of. Treatment of the sphenopalatine ganglion to relieve pain and congestion is a procedure that is often useful because of the reflex action on the arteries of the optic nerve and eye. Therapy consisting of injections or surgical procedures is directed to the globe. In cases of obliteration of the central retinal artery, sclerotomy, iridectomy and extraction of the transparent lens have been employed.

In cases of pigmentary degeneration of the retina certain ophthalmologists, notably Magitot, have had success with sympathectomy. When impeded circulation is apparent massage of the globe by manual or

mechanical means is often indicated. Retrobulbar injections of various chemicals, such as atropine, acetylcholine and mercuric oxycyanide, have given favorable results. Procaine hydrochloride and hypertonic salt solution may be helpful. In cases of hemorrhage of the retina epinephrine hydrochloride gives beneficial results. Alcohol is injected retrobulbarly to reduce pain. All solutions injected should be used at body temperature.

L. L. MAYER.

PAPILLARY STASIS AND SYPHILIS. E. HARTMANN, M. DAVID and L. GUILLAUMAT, *Bull. Soc. d'opt. de Paris* 50: 461 (Oct.) 1938.

Three cases of papillary stasis associated with syphilis are cited in order to throw some light on the mechanism of the condition.

The first patient had a negative Wassermann reaction of the spinal fluid and symptoms of a tumor of the frontal lobe with paralysis of the facial nerve and bilateral papillary stasis. Ventriculographic examination confirmed the diagnosis. A gumma of the frontal lobe was found at operation. The Wassermann reaction of the blood was positive after operation. The papillary stasis subsided after surgical removal of the gumma.

The second patient had a syndrome of intracranial hypertension with papillary stasis. The Wassermann reaction of the spinal fluid was positive. Neurologic examination gave negative results. Ventriculographic examination revealed markedly dilated ventricles, and at operation a cystic arachnoiditis involving the cerebellar lobes and the vermis was found. The nodules in the arachnoid were characteristic granulomas. The papillary stasis disappeared after operation.

The third patient had encephalitis with cerebral edema during the time of appearance of the secondary lesions of syphilis. There was papillary stasis to 8 diopters. After decompression and antisiphilitic treatment the optic nerve and retina returned to normal.

The authors comment on and discuss the various modes of production of papillary stasis in these 3 cases.

L. L. MAYER.

CONTRIBUTION TO THE KNOWLEDGE OF ANGIONEUROTIC MACULAR RETINAL DEGENERATION. F. L. CANDIAN, *Ann. di ottal. e clin. ocul.* 66: 824 (Nov.) 1938.

The author has chosen the name angioneurotic macular retinal degeneration for the condition described by Horniker as angiospastic retinitis. Candian examined his patient for disorders of the neurovegetative apparatus and recorded the capillary pressure in the retina by the amount of pressure with Bailliart's dynamometer necessary to produce a slowing of the blood stream in the finer retinal vessels and finally complete interruption as seen by the patient entoscopically. It is admitted that this method has only a relative value, as it depends on the subjective impression of the patient.

Twelve cases are reported. The author considered the condition in 6 to belong to the type of angioneurotic macular degeneration described by Horniker as occurring in otherwise normal persons. It is to be noted, however, that in 3 of these 6 cases, there was some elevation of

the general blood pressure, which makes them somewhat atypical. In 3 of the other 6 there was essential hypertension and in 3 signs of nephritis. Common to all were abnormalities in capillary tone, as shown by the dynamometric findings. The estimated pressure in the capillaries was usually high in relation to systemic blood pressure, being low in only 2 cases. The signs and symptoms in the typical cases were those described by Horniker. Sudden loss of central vision with the appearance of a positive scotoma was common, while in some the loss of vision was slight, the only symptom being that of a veil before the vision of one eye. The fundus in early states showed edema of the macula, often with a ring reflex about the macular region. A few small hemorrhages were often present. Later, areas of retinal atrophy appeared, with some fine white or yellowish spots in the macular region. Vision returned to normal, or nearly so, in most cases when treatment was directed to the relaxation of capillary spasm. Papaverine, phenobarbital and calcium were frequently employed. Six colored fundus pictures and a bibliography accompany the article.

S. R. GIFFORD.

**PATHOGENESIS OF PAPILLEDEMA.** E. ADROGUE and J. TETTAMANTI, Arch. de oftal. de Buenos Aires 13: 597 (Nov.) 1938.

The different theories of the pathogenesis of "choked disk" are reviewed. The authors discard the inflammatory and neural theories and uphold the mechanical explanations.

The histologic changes in 7 cases are described.

The authors conclude that none of the existing mechanical theories suffice to explain the pathogenesis of this condition.

The tumors of the posterior cranial fossa in the neighborhood of the sylvian aqueduct produce "choked disk" with greater frequency and intensity than those in other regions.

The beneficial results of decompressive craniotomy and intraventricular puncture prove the importance of a disturbance in the circulation of the intracranial fluid in the genesis of this condition.

Orbital tumors rarely produce papilledema.

The photomicrographs of the cases here reported show that the lamina cribrosa usually occupies its normal position. In the majority of cases the vaginal space is dilated.

The mechanism of its production in arterial hypertension is mostly attributed to cerebral edema, decompressive craniotomy being effective.

Finally, the authors state that the mechanism of the production of papilledema is still obscure, but they incline notwithstanding to the mechanical explanation.

C. E. FINLAY.

### Trachoma

**TRACHOMA IN AMERICAN SAMOA.** F. HARBERT, Am. J. Ophth. 21: 403 (April) 1938.

Harbert gives the following conclusions of his study of trachoma in Samoa:

"1. The prevalence of trachoma in Samoa is established by clinical and laboratory investigation.

"2. Samoan trachoma has a tendency to spontaneous arrest unless complicated by secondary infection, which causes a high percentage of blindness.

"3. A simple clinical classification of pannus based on macroscopic examination is suggested."

W. S. REESE.

STUDIES ON THE INFECTIVITY OF TRACHOMA. L. A. JULIANELLE and R. W. HARRISON, *Am. J. Ophth.* 21: 529 (May) 1938.

Julianelle and Harrison give the following summary:

"Under the conditions of experimentation outlined, it has been determined that the virus of trachoma is unable to resist environmental changes such as desiccation, freezing and thawing, and moderate heat. Consequently, it has not been possible to preserve the virus over an appreciable length of time by physical methods. So, also, preservation in glycerine has been unsuccessful.

"In the presence of chemical substances, such as bile, gentian violet, tartar emetic, silver nitrate, phenol, and cocaine, the infectious agent of trachoma is rapidly inactivated.

"Antigenically, the infectious agent appears to be ineffectual, since it stimulates neither antibody formation nor increased resistance during active infection."

W. S. REESE.

### Tumors

PRIMARY GLIOMA OF THE OPTIC NERVE AND CHIASM. A. LUNDBERG, *Arch. d'ophth.* 1: 97 (Feb.) 1937.

In this work 9 cases of glioma of the optic nerve and chiasm are described. The growths all belonged to the group of gliomas due to oligodendrocytomas, which was in accordance with their relatively benign clinical development.

S. B. MARLOW.

VOLUMINOUS NEVOCARCINOMA OF THE REGION BETWEEN THE EYEBROWS. E. PUSCARIU, *Arch. d'ophth.* 1: 601 (July) 1937.

Nevocarcinoma is one of the tumors which is not commonly encountered clinically. The author's incidence was 5 cases in 7,000 observations. A case is described and illustrated with a photograph and a drawing of a section.

S. B. MARLOW.

CYLINDROMA OF THE ORBIT. E. PUSCARIU, *Arch. d'ophth.* 1: 961 (Nov.) 1937.

The questions as to whether a cylindroma of the orbit is epithelial or endothelial in origin and from what structure in the orbit it arises are discussed by reviewing the opinions of those who have encountered and studied it. Clinical observations are of little help in settling the question. A case is described, and a photograph of the patient and photomicrographs and drawings of the tumor are included. It is a rare tumor, being the only 1 in a series of 7,000 hospital patients and a group of 20 orbital tumors.

S. B. MARLOW.

## Uvea

THE GENESIS OF THE CYCLITIC MEMBRANE. H. D. LAMB, *Am. J. Ophth.* 21: 503 (May) 1938.

After a discussion of cyclitis, Lamb gives the following summary:

"The characteristic cell of the exudate on the free surface of the ciliary body in chronic cyclitis is the macrophage. The conversion of macrophages into fibroblasts or connective-tissue cells is described and illustrated in a case in which the fibroblasts have been sectioned on the flat. This occurrence in the vitreous adjacent to the ciliary body is the earliest stage in the development of the cyclitic membrane. Neither layer of the ciliary epithelia or retinal part of the ciliary body participates in the formation of the cyclitic membrane, although the pigmented epithelial cells can, under certain conditions, change into connective-tissue cells.

"The transformation of macrophages into fibroblasts is not a newly discovered process, having been observed in tissue cultures by Carrel, Maximow, and deHaan."

W. S. REESE.

MILIARY TUBERCULOSIS OF THE CHOROID. A. HUDELO and J. VOISIN, *Arch. d'opht.* 1: 198 (March) 1937.

The authors describe in detail a case in which the diagnosis of tuberculosis was not made until some neurologic symptoms appeared and typical tubercles in the choroid were found with the ophthalmoscope. The postmortem histologic study revealed a somewhat different type of pathologic process than that described by Bollack, Hillemand and Laporte. In this case the tuberculous lesions were at different stages of development.

S. B. MARLOW.

NEW OBSERVATIONS ON IRITIS ROSACEA: REPORT OF A CASE. E. OLÁH, *Klin. Monatsbl. f. Augenh.* 100: 714 (May) 1938.

A man, aged 54, had never suffered from any ocular condition until two weeks prior to his admission to the hospital, when his left eye suddenly became reddened. Pain and photophobia of a minor degree were present; vision remained satisfactory. The left eye showed slight injection; the cornea looked healthy and was free from precipitates. The peripheral zone of the iris was an even brownish gray, and the design was indistinct; the pupillary zone was of a normal color, and the design was well defined. The pupillary reaction to light was sluggish. The pupil dilated promptly, but moderately, on instillation of scopolamine hydrobromide, only the pupillary zone being affected. The vitreous and fundus were normal. The dilatation of the pupil remained unchanged, although scopolamine hydrobromide was instilled daily. The peripheral, or ciliary, portion of the iris did not react until after the patient's recovery two months later. Obesity, facial rosacea and atrophy of one testicle were noted. Two brothers presented the same symptoms, whereas the patient's sisters were slender, and the skin of their faces was white.

Oláh stresses the fact that rosacea was not observed in the conjunctiva or cornea, contrary to their involvement in the other 5 recorded cases of iritis rosacea. Hence, the iritis rosacea of Oláh's patient was primary and was not the secondary result of a toxicity arising from the cornea, as pointed out by Salus. The endocrine origin was proved by the result of hormonal therapy, which consisted of injections of a combination of extracts of the thyroid and adrenal glands, the testis and the pituitary gland. A trial of this treatment is recommended in cases in which the condition is resistant to therapy, as it may be used without risk.

K. L. STOLL.

### Therapeutics

THE ROLE OF TRANSFUSION IN OPHTHALMOLOGY. W. G. FREY, *Am. J. Ophth.* 21:491 (May) 1938.

Frey remarks the few uses ophthalmologists have found for transfusion. From a review of its uses in ophthalmology, he concludes that its value in arresting hemorrhage or replacing massive loss of blood is unquestioned, whereas in inflammatory lesions further investigation is necessary. It is also valuable in stimulating trophic lesions of the eye, though this stimulation is not maintained and may need to be repeated. In general, transfusion furnishes a splendid nonspecific therapeutic reinforcement.

W. S. REESE.

NOTE ON A NEW METHOD OF TREATMENT OF OCULAR SPARGANOSIS. KEELER, *Arch. d'opht.* 1:779 (Sept.) 1937.

Twelve cases of ocular sparganosis are described, in all of which treatment with neoarsphenamine gave equally good results. With one exception the condition was unilateral, the right eye being involved in 8 cases. One patient lost one eye due to neuromyolytic keratitis, as she refused tarsorrhaphy and left the hospital against advice. Tarsorrhaphy was performed in 3 cases, and in 3 cases the parasites were recovered on the dressings. The duration of the treatment was forty days in 8 cases, twenty days in 2 and three months in 2. Neoarsphenamine in the author's experience is the best treatment for this condition. Its use obviates mutilating surgical treatment.

S. B. MARLOW.

# Society Transactions

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## ASSOCIATION FOR RESEARCH IN OPHTHALMOLOGY

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*May 16, 1939*

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THE OCULAR SHWARTZMAN PHENOMENON. DR. T. E. SANDERS, St. Louis.

The phenomenon of local tissue reactivity, or the Shwartzman reaction, was first described by that author in 1928. 1. He found that if a filtrate of a culture of typhoid bacilli is injected intradermally in a rabbit, only a moderate erythema appears in about twenty-four hours, which promptly subsides. However, if twenty-four hours after the cutaneous injection the filtrate is injected intravenously, in a few hours there appears an extremely severe hemorrhagic necrosis at the site of the local injection. . Histologically, the preliminary injection leads to an exudative inflammation of slight degree. After the subsequent intravenous injection, the inflammation becomes much more severe and is accompanied by vascular thrombosis, vascular necrosis and hemorrhage. 2. A large number of organisms other than the typhoid bacillus, such as the meningococcus, the gonococcus and the cholera vibrio, produce potent filtrates. 3. After local injection in other sites, the reaction has been found to occur in such organs as the liver, kidneys, stomach and joints, but the second, or reacting, injection must always be intravenous.

There are only five papers in the literature on the Shwartzman reaction in the eye, three in Italian and one each in French and Russian, there being no papers on the subject in English. They indicate that the reaction is usually positive in the conjunctiva and always negative in the cornea, but the results intraocularly seem inclusive. As a part of a study of ocular hypersensitivity, a typhoid filtrate as originally described by Shwartzman was used, and the reaction was studied in the conjunctiva, anterior chamber and vitreous.

### DISCUSSION

DR. A. DE ROTTH, Chicago: I should like to know if Dr. Sanders tried to produce the Shwartzman reaction in vascularized cornea? After provoking vascularization by cautery, I produced the typical reaction with a filtrate of colon bacilli. I assume that the capillaries are damaged by the toxin of the preparatory injection.

DR. T. E. SANDERS, St. Louis: I did not include the one or two experiments in which I used the cornea, because I wanted to have a few more eyes to study before I reported the results. In the experiments in

which I did try the intracorneal injection, vascularization was produced by the use of *Bacterium monocytogenes*, with which Dr. Julianelle has been working. The chief differential characteristic of this organism is that if it is instilled in the eye it produces marked pannus and keratitis. I tried to produce the phenomenon in the corneas of one or two of these animals, but I did it before the marked keratitis produced by the organism had disappeared, so that the corneas were soft and not normal.

I did not get the typical reaction, probably because of the marked inflammation caused by the infection. I will try to produce more of these reactions in corneas which have been allowed to heal a little more and have only the vessels without the inflammatory reaction.

DR. SANFORD H. GIFFORD, Chicago: Has the Shwartzman phenomenon been elicited by filtrates of tubercle bacilli? Can it be responsible for some focal reactions to tuberculin?

DR. T. E. SANDERS, St. Louis: The tubercle bacillus is one of the organisms that has a less potent filtrate, and most of the experimental work has been done with *Bacillus coli*, *Bacillus typhosus* and *Meningococcus*. However, there is some evidence that the phenomenon could be a factor in the production of a focal reaction to tuberculin.

INVASION OF THE ANTERIOR SEGMENT OF THE EYE BY SURFACE EPITHELIUM. DRs. T. L. TERRY, J. F. CHISHOLM JR. and A. L. SCHOENBERG, Boston.

Several observers have accepted hypotony and a persistent gaping wound as essential factors for the invasion of the eye by surface epithelium. One other observer believes that sufficient nutrition must be provided in the form of a conjunctival flap. Evidence that extraneous tissue of several sorts can live within the eye suggest that no great inhibiting factors are inherent in the aqueous.

At the Massachusetts Eye and Ear Infirmary in the last thirty-nine years there have been 45,500 consecutive instances of accidental and operative wounds of the interior segment of the eye. During this period only 28 specimens of epithelization of the interior of the eye have been studied in the pathologic laboratory. These 28 cases indicate that epithelization following accidental perforation is more common in man probably because of the greater frequency of perforating injuries to men in industrial work.

Development of epithelization is almost invariably evident within twenty-four months. A persistently gaping wound is not necessary, since epithelium can grow into the chamber along a wound in forty-eight hours and can be introduced even by discission. Likewise, hypotony is not invariably necessary, since epithelization has spread in glaucomatous eyes.

The extent of growth may be limited by mechanical barriers, which may produce cyst formation. In the absence of these barriers, epithelium is to be found at times on the apparently normal epithelium of the posterior surface of the iris, on the ciliary processes and even on the hyaloid membrane. Endothelium on the back of the cornea appears to be an insuperable barrier. In fact, the absence of endothelium seems to be a necessary criterion for the adherence and growth



of epithelium on the cornea. Toxins produced by the eye or by the epithelium and lack of nutrition are conjectured as other possible inhibitors.

Glaucoma does not invariably follow epithelization. When glaucoma is present, it is usually associated with blockage of the iridocorneal angle by the ordinary anterior peripheral synechia, not by the aberrant epithelium itself. However, particulate matter from desquamated epithelial cells may block the angle in the same manner as exfoliated particles from the lens capsule.

The epithelium may be carried in (a) by a free accidental graft caused by surface irregularity of the knife or puncturing instrument, (b) by a downgrowth of epithelium along a wound, (c) by conjunctival flaps accidentally turned into the eye or possibly (d) by a downgrowth along a suture placed too deeply and left in the eye for a long period.

The "growth force" of the epithelium within the eye is probably weak. In that event, roentgen rays or radium in relatively small doses may stop or even destroy the aberrant epithelium. There is, however, one instance in the series of cases in which roentgen irradiation was without benefit.

There are various experimental methods of producing epithelization. These methods are not invariably successful.

#### DISCUSSION

DR. DERRICK VAIL, Cincinnati: Was the histologic picture in this case in which roentgen irradiation was used any different from that in the other cases?

DR. T. L. TERRY, Boston: Not that we are able to discern. We found the same changes that were presented in other eyes. The epithelium seemed healthy and vigorous. We are not sure how much roentgen irradiation was given, a weak point in presenting the case.

DR. P. HEATH, Detroit: I should like to ask Dr. Terry if he and his co-workers noted sources of epithelium other than conjunctiva and cornea?

DR. T. L. TERRY, Boston: In our work we noted none at all. In the literature there is the statement that hair follicles are found in the anterior chamber. Of course there is a large amount of work reported in the literature concerning the grafting of all sorts of tissue within the eye. I omitted that from the reading of the paper because the time was getting short, but one investigator attempted to put all sorts of tissue in the eye, and he found that in 75 per cent of eyes in which he had put fat, placenta, cornea, retina, ovary, liver, spleen and bone, the tissue disappeared. Yet there has been a considerable amount of work in which material has been grafted into the eye by free transplant, just a piece dropped in. Usually this is done by persons who are not ophthalmologists but who are interested more in ovarian function or endometrium. This material almost invariably gains vascularization from the iris, so that one is unable to ascertain the effect of aqueous on it.

Ovarian tissue that was placed in the eye did not give rise to any function until the female animals were castrated. Attempts were made to fertilize matured ova, but without success. Fertilized ova that had

been washed out of the genitalia could not be made to develop in the anterior chamber. A blushing and blanching phenomenon of the implanted endometrium, typical of ovulation, can be brought about by the administration of certain extracts of internal secretions, by cutting the spinal cord and by other methods.

DR. CLYDE A. CLAPP, Baltimore: I should like to ask Dr. Terry if he can clinically differentiate between epithelization of the anterior chamber and an inflammatory membrane; what becomes of the endothelium cells on the posterior surface of the cornea when epithelization takes place, and why operations for glaucoma are unsuccessful in cases of epithelization?

DR. T. L. TERRY, Boston: Usually the first evidence one has that epithelization has occurred is from microscopic examination of the pathologic specimen. A diagnosis was made clinically in about 5 cases. The clinical picture is by no means definite. Dr. Verhoeff told me recently of an eye enucleated because of a clinical diagnosis of epithelization in which there was no evidence of aberrant epithelium on microscopic examination. He did not say what gave the clinical picture of epithelization. No doubt a thin film of exudate or a disease of the endothelium or dislocation of Descemet's membrane might give the same clinical picture.

DR. CLYDE A. CLAPP, Baltimore: Can a differentiation be made microscopically?

DR. T. L. TERRY, Boston: The differentiation can be made from a microscopic study of a section.

Epithelization does not occur where there is endothelium. I am unable to say exactly what happens to the endothelium. I feel that the endothelium is destroyed as the epithelium slowly advances and that the epithelium advances slowly because the endothelium present acts as a mechanical barrier. It is known that epithelium grows more rapidly under normal conditions than endothelium, and if the epithelium is desquamating, giving off certain toxins, it is possible that that material may be toxic to the endothelium.

I do not feel that glaucoma is responsible for the death of the endothelium. I feel that trauma of operation may be an important factor in destroying it. The introduction of an irrigator tip, an iris repositor or of various instruments may scrape and injure the back of the cornea. When cataract is not present, an attempt is made to keep instruments close to the back of the cornea for fear of producing one. This endangers the endothelium. How the endothelium disappears, I do not know.

The epithelium does not fill the angle in most instances in which glaucoma is present. The glaucoma seems to result from a blockage of the iridocorneal angle, and there is reason to believe that it is due to blockage by desquamating epithelium in the form of particulate matter. The debris would ordinarily produce pseudocholesteatomatous material in an epithelial cyst. Similarly, some observers feel that exfoliated capsular material as particulate matter may produce certain changes at the iridocorneal angle.

DR. CLYDE A. CLAPP, Baltimore: Why does operation not cure these patients with glaucoma if it is not due to epithelization? One can operate and keep on operating, and still the tension stays up.

DR. T. L. TERRY, Boston: When epithelization is present, there is no endothelial covering and not as much protection against fibrosis.

DR. RODMAN IRVINE, Los Angeles: Do blood vessels always accompany the epithelium?

DR. T. L. TERRY, Boston: May I ask, in relation to the epithelium or in relation to other parts?

DR. RODMAN IRVINE, Los Angeles: Is the epithelium growing from it always accompanied by blood vessels?

DR. T. L. TERRY, Boston: Blood vessels are not usually found in the cornea in the microscopic specimens. One criterion that a great many persons stress is that epithelization on the back of the cornea will cause vascularization of the cornea. We have not observed vascularization on the specimens studied.

In one of the experimental cases—I did not show the slide—an epithelial cyst was produced, and the back surface of the cyst was covered with vascularized scar tissue, the blood supply coming from the iris. It seems that the epithelium grows much better if it is growing on a structure that has good nutrition. It grows much better on the iris than on the back of the cornea, and in instances in which cysts are formed it grows better on the back of the cornea than on the thin membrane of scar tissue separating it from aqueous.

#### METHEMOGLOBIN-PRODUCING ORGANISMS IN OCULAR INFLAMMATION.

DR. MAYNARD A. WOOD, Iowa City.

From Sept. 1, 1937, to May 1, 1939, 365 strains of methemoglobin-producing organisms were isolated from 354 patients. These bacteria were either *Streptococcus viridans* or *Diplococcus pneumoniae*. The principal criteria for differentiating the two were bile solubility and reaction to specific immune antisera. However, additional differentiating data were obtained from cultural characteristics on solid and liquid mediums, microscopic morphologic structure and action on inulin.

Two hundred (55 per cent) of the strains were identified as *Str. viridans* and 165 (45 per cent) as *D. pneumoniae*. In cases in which the conjunctiva appeared to be normal 57 of these strains were obtained, 32 (56 per cent) of which were *Str. viridans* and 25 of which (44 per cent) were *D. pneumoniae*.

Approximately 100 strains of pneumococci were typed by the macroscopic agglutination method (Cooper). Type VII occurred most frequently (24 per cent) and was followed in order by types XIV (11 per cent); XXIII (10 per cent); XIX (6 per cent); III (5 per cent); VI, X, XVII, XVIII and XX (each 4 per cent); XI, XVI, XXII and XXIX (each 3 per cent); XV (2 per cent) and X, XXI, XXIV, XXV, XXVIII and XXXI (each 1 per cent).

In each of the 11 cases of hypopyon ulcer, *D. pneumoniae* was found to be the causative organism.

Ocular strains of *D. pneumoniae* were surprisingly avirulent for mice.

## DISCUSSION

DR. SANFORD H. GIFFORD, Chicago: From how many normal conjunctivas were the positive cultures made?

DR. MAYNARD A. WOOD, Iowa City: Approximately 1,000 cultures were taken routinely in all cases before operation. These cases include, of course, cases of cataract, squint, glaucoma and other ocular diseases.

ROLE OF THE CERVICAL SYMPATHETIC GANGLIONS AND MÜLLER'S ORBITAL MUSCLE IN EXPERIMENTAL EXOPHTHALMOS. DR. GEORGE K. SMELSER, New York.

In order to determine the role of Müller's orbital muscle in the production of experimental exophthalmos and the orbital pathologic process accompanying it, this sheet of smooth muscle constituting the floor of the orbit of the guinea pig was removed from the right eye of approximately 50 guinea pigs. Both cervical sympathetic ganglions were removed from one third of the animals; only the sympathetic ganglion supplying the orbit on which operation was performed was removed from a third, and the sympathetic ganglions and fibers were left intact in the remaining animals.

Removal of the cervical sympathetic ganglions from the guinea pig produces a definite ptosis and slight enophthalmos, which persists indefinitely. Removal of Müller's orbital muscle, however, produces ptosis similar to that following ablation of the sympathetic ganglions, but the degree of enophthalmos is more marked. This ptosis results partly from the sinking inward of the globe, which normally partially supports the lids, and partly from interference with the lower lid caused by the operative procedure. In the absence of Müller's muscle the orbital contents drop until they are supported by the striped pterygoid muscle and other structures of the soft palate and cheek.

The intraorbital operation produces a connective tissue reaction which causes an increase in the weight of the retrobulbar tissues in comparison with the weight of the tissues of the opposite eye, which has not been operated on. Removal of the cervical sympathetic ganglions on either side or on both sides has no effect on the weight of the orbital contents.

Injection of an extract of anterior lobe of the hypophysis produced a definite exophthalmos in normal eyes. As previously reported, removal of sympathetic ganglions greatly reduces the appearance of proptosis. However, the exophthalmos can be seen to equal that of normally innervated eyes if comparisons are made post mortem after removal of the skin and lids.

Exophthalmos never became marked in those cases in which Müller's muscle was removed, although some effect was noted by inspection in comparison with controls and by measurements of the palpebral fissure.

Autopsy data revealed that a marked increase in mass of the retrobulbar tissues resulted from injection of anterior pituitary extract, as noted in earlier reports. This increase, believed responsible for the exophthalmos, occurred equally in normally innervated orbits and those from which Müller's muscle and the sympathetic innervation had been

removed. The less noticeable protrusion in eyes of orbits on which operation has been performed results from the "decompression" after removal of the muscle.

In these experiments no relation was discovered between sympathetic innervation of Müller's orbital muscle and the increased orbital tissues and accompanying pathologic process as found in clinical and experimental exophthalmos.

#### DISCUSSION

DR. WILLIAM L. BENEDICT, Rochester, Minn.: I should like to ask Dr. Smelser if he noticed any difference in the length of time required in the development of exophthalmos in the animals on which sympathectomy was not done?

DR. GEORGE K. SMELSER, New York: Dr. Benedict's question is a little difficult to answer because the exophthalmos is not as apparent in an animal in which there is some ptosis. However, by palpation of the globe through the lid and by autopsy of the animals at various stages after the first injection, it does not appear that there is any difference in the speed with which exophthalmos develops in animals deprived of their cervical sympathetic ganglions or the orbital muscle of Müller.

All the animals reported on in this series were subjected to autopsy within a few days of each other, so that the length of time between injection of the pituitary extract and autopsy was comparable in the three groups.

ROLE OF BRUCELLA IN HUMAN AND ANIMAL OCULAR DISEASE, WITH SPECIAL REFERENCE TO PERIODIC OPHTHALMIA IN HORSES. DR. EARL L. BURKY, MR. ROBERT REDVERS THOMPSON and MISS HELEN M. ZEPP, Baltimore.

*Brucella* (species undetermined) has been recovered at necropsy from the ovaries and milk of 3 mares killed because of blindness due to clinical periodic ophthalmia. A fourth strain has been recovered from the milk of a mare with a similar ocular condition.

Injection of the first strain to be recovered into the anterior chamber of rabbits or intravenously into rabbits and guinea pigs produces in some, but not all, animals ocular inflammation resembling periodic ophthalmia in horses and recurrent intraocular inflammation in human beings.

It is suggested that because of the experimental results and clinical observations made in the field, infection with *Brucella* may be the cause, or one of the causes, of periodic ophthalmia. In addition, the experimental results, coupled with clinical observations already reported in the literature, suggest that this infection may play an important role in human ocular pathologic conditions.

#### DISCUSSION

DR. CLYDE A. CLAPP, Baltimore: Dr. Burky's case was one of uveitis which started first in the left eye and was then followed in about six months by occurrence in the right eye. In spite of various diagnoses,

antisyphilitic treatment and tuberculin treatment, the condition of the eyes gradually become worse, the left eye becoming entirely blind and vision in the right eye decreasing to 2/200.

As Dr. Burky said, there have been various diagnoses, and we are in hopes at the present time that the proper one has been made.

DR. JOHN GREEN, St. Louis: I have a rather striking case, which has still not been reported, which seems to indicate that the brucella may be the cause of choroiditis, resembling clinically tuberculous choroiditis.

#### EXPERIMENTAL PRODUCTION OF CONJUNCTIVITIS WITH STAPHYLOCOCCI. DR. JAMES H. ALLEN.

Conjunctivitis was produced experimentally in rabbits and infants with hemolytic strains of *Staphylococcus aureus*.

Meibomitis and conjunctivitis were produced in rabbits by injecting small amounts of broth cultures of *Staph. aureus* into the meibomian glands. This was accomplished under a dissecting microscope by inserting a capillary pipet into the mouth of a meibomian gland of a rabbit anesthetized with pentobarbital sodium. An acute infection of the meibomian gland and conjunctiva persisted for two to three weeks and was followed by a chronic infection of the gland and conjunctiva of six to eight months' duration. Similar inoculations made into the meibomian glands of toxoid-immunized rabbits, possessing 40 to 60 units of antitoxin per cubic centimeter of serum, resulted in an acute inflammation of the gland, but it subsided in less than a week. Almost identical results were obtained in nonimmunized rabbits with a non-hemolytic strain of *Staphylococcus albus*.

An acute catarrhal type of conjunctivitis was produced in infants by the instillation of three hour broth cultures of *staphylococcus* toxin. However, conjunctivitis did not develop in some of the infants. The serum of each was titrated for antitoxin, and those infants in which conjunctivitis did not develop were found to have at least 0.5 unit of *staphylococcus* antitoxin per cubic centimeter of serum. Instillation of three hour broth cultures of a nonhemolytic strain of *Staph. albus* did not produce conjunctivitis.

#### A NOTE ON THE IMMUNOLOGY OF TRACHOMA. DR. LOUIS A. JULIANELLE, St. Louis.

Earlier recorded observations disclosed that the virus of trachoma appears to be an impotent antigen in stimulating immunity. Thus, monkeys recovering from experimental infection retain their original susceptibility to the infection, and blood of patients in different stages of the disease contains no antibodies capable of neutralizing the virus prior to inoculation in monkeys. In continuing the study, attempts were made to hyperimmunize both rabbits and monkeys (the latter of proved susceptibility) by repeated intravenous injections of active conjunctival material obtained by grattage of patients. The resultant antisera were found to be highly lytic for the different cells contained in the material used for the injections, thus indicating that sufficient time and treatment had been given to invoke antibodies for any of the functionable antigens present in the immunizing material.

Protection, or neutralization, tests were subsequently conducted with both rabbit and monkey antiserum by incubating over varying periods of time active trachomatous tissues from patients mixed with different dilutions of the serums. In no instance was it possible to show that antisera obtained in the manner described contained any antibodies operable against the virus of trachoma. The indications are, therefore, that the causative agent of this disease is as impotent an antigen as originally reported from my laboratory at Washington University.

The bearing of this study on practical ophthalmology resides in an apparent rebuttal of the concept prevalent among numerous ophthalmologists, particularly abroad, in the treatment of trachoma by subcutaneous or subconjunctival injections of serums from trachomatous patients.

#### DISCUSSION

DR. WILLIAM L. BENEDICT, Rochester, Minn.: I should like to ask Dr. Julianelle if he has any notion as to whether the low antigenicity which he has demonstrated by his experiment has any bearing on whether or not the etiologic agent of trachoma is really a virus.

DR. LOUIS A. JULIANELLE, St. Louis: There is an unfortunate impression which was caused by Rivers' book on viruses, published about ten years ago, in which he generalized so thoroughly as to what a virus should be. He flat-footedly stated in that book that all viruses are fine antigens and that the result is that recovery from a virus disease gives a life-lasting immunity.

At that time not many viruses were known, and the statement was about 90 per cent true. Today it is about 60 per cent true. A number of viruses have become known since then that do not give any measurable immunity or any extensive immunity. I think, therefore, that one cannot define the nature of an infectious agent by the extent of immunity alone.

#### VITAMIN D COMPLEX IN MYOPIA: CAUSATION, PATHOLOGIC PICTURE AND TREATMENT. DR. ARTHUR ALEXANDER KNAPP, New York.

From experimental work done on dogs, it was believed that the vitamin D-calcium-phosphorus complex was concerned in the causation of myopia. Rickets was induced in these animals by a diet deficient in vitamin D and low in calcium. Clinically, they manifested suggestive evidence of myopia. Microscopically, the fibrous tunic was found to be weakened.

Because of these findings and because of the observations of previous workers, 53 persons with apparently progressive myopia were selected from thousands of patients at the New York Eye and Ear Infirmary. Their myopia ranged from —.25 to —41.00 diopters. They were given vitamin D and calcium. The period of investigation varied from five to twenty-eight months.

Before this therapy was administered, however, refraction was done under 10 drops of a 1 per cent solution of atropine. Retinoscopic examination, when possible, was done, followed by the acceptance. At intervals during the course of the treatment, further refraction under atropine cycloplegia was carried out.

It was found that in some cases the myopia actually was reduced; in a few it remained stationary; in still others there was a progression, and in 2 there was a reduction in one eye with a progression in the other. Without any, or with very little, intake of the vitamin D and calcium, 2 patients revealed an increase of their myopia, which was reduced with the regular administration of the indicated therapy.

There is some clinical evidence to support the opinion of reduction of myopia by shrinkage of the globe. To check further, accurate measurements of casts of eyes with anterior curvature myopia were made. Shrinkage of the cornea and sclera were demonstrated. Improved subjective and objective vision also was noticed, along with less dependence on glasses.

#### DISCUSSION

DR. ALLEN GREENWOOD, Boston: I should like to ask Dr. Knapp a question in regard to his first patient. Were careful slit lamp examinations made of the lens from time to time? He spoke of the lenses as being cataractous. I was wondering whether he kept careful records of the slit lamp appearance of the lenticular changes from time to time, if there were any.

DR. ARTHUR ALEXANDER KNAPP, New York: I shall publish the history of this case as a separate entity. It was exceedingly interesting. The eyes were frequently examined with aid of the slit lamp, and records were kept.



## Book Reviews

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**Traité d'ophtalmologie.** Published under the auspices of the Société française d'ophtalmologie, by P. Bailliart, C. Coutela, E. Redslob, E. Velter and R. Onfray, general secretary. Eight volumes, pp. 8,058, with 176 plates in colors. Subscription unbound edition, 2,500 francs; bound edition, 2,800 francs (prices raised after September 1). Single volume, 350 or 400 francs. Paris: Masson & Cie, 1939.

The plan of this handbook is to furnish all that the ophthalmologist should know about his specialty and the related subjects. In addition to a complete exposition of anatomy, physiology, pathology, clinical ophthalmology, surgical technic and laboratory work, there are chapters on pure science, physical optics, comparative pathology and the general treatment of syphilis, tuberculosis, endocrine disorders and other general diseases which the ophthalmologist encounters in his practice.

The enormous mass of information contained in this work, which is both a treatise and a book of practice, is made available and readily accessible by two tables: (1) a logical table of contents and (2) an alphabetical list of 12,000 items. In this list reference is made to a complete bibliography of about 600 pages, which is to be found in each volume in its appropriate place.

The system is written by more than 100 French collaborators who have worked in cooperation with a committee formed by the Société française d'ophtalmologie. The list of authors is an imposing one, and the handbook will stand for all that is good in French ophthalmology.

Many years have passed since the "Encyclopédie française d'ophtalmologie" appeared. Ophthalmology has made many advances, and the way of presenting medical subjects has changed, so that this undertaking is most timely. To judge by volumes I and II, which have just appeared, all expectations are going to be realized, and French ophthalmology may feel proud of the unqualified success that this work will achieve. The bookmaking is excellent; the paper and type are good, and the illustrations are unusually clear.

A general table of contents, 77 pages, is given in the beginning of volume I, and the general alphabetical index is placed at the end of the last volume (VIII). At the top of each page in the text will be found the page location of the bibliography of the subject under discussion.

Volume I contains 1,106 pages, 643 figures, 4 plates in color and a general table of contents of the treatise. There is an excellent chapter on the history of ophthalmology by H. Villard, consisting of 87 pages, and the remaining chapters are on embryology and anatomy under the following headings: "General Development of the Visual Apparatus," by G. Leplat; "Embryology" and "Comparative Embryology," by C. DeJean; "Anatomy of the Orbit," by G. Winckler; "Anatomy of the Lacrimal Apparatus" and "Ocular Vessels," by

G.-E. Jayles; "Anatomy of the Eyeball," by E. Redslob; "Anatomy of the Optic Pathways," by J. Lhermitte; "Anatomy of the Oculomotor Apparatus," by P. Van Gehuchten; "Anatomy of the Sensory Apparatus," by L. Cerise and R. Thurel; "Anatomy of the Sympathetic and Parasympathetic Nerves Which Innervate the Eyeball," by A. Tournay; "Comparative Anatomy and Physiology," by A. Rochon-Duvigneaud, and "Heredity" and "Teratology," by M. Van Dyse.

Of the many excellent chapters, Redslob's chapter on the anatomy of the eyeball and Rochon-Duvigneaud's on comparative anatomy and physiology are especially to be commended, not only for their subject matter but for the number and selection of the illustrations.

Volume II contains 1,150 pages, 693 illustrations and 5 plates in color and takes up physiology and methods of examination.

The subject matter is arranged in the following chapters: "Eyelids and Lacrimal Apparatus," by A. Magitot and R. Rossano; "Sensation of the Eyeball and Its Examination," by L. Cerise and L. Thurel; "Nutrition and Circulation of the Eye," by P. Bailliar; "Conjunctival Circulation," by A. Rollin; "Intraocular Fluid and Nutrition of the Eyeball" and "Ocular Tension," by A. Magitot; "Physiology of the Extrinsic Ocular Muscles," by J. Nordmann; "Intrinsic Muscles," by A. Magitot; "Theoretic and Applied Optics," by E. Haas; "Physiologic Optics," by H. Joseph; "Biologic Optics" and "Absorption of Radiant Energy by the Ocular Tissues," by G. Leplat; "Entoptic Phenomena," by H. Viallefont; "Changes in the Retina Produced by Light," by A. Magitot; "Physiology of Vision," "Visual Stimulation," "Theories on Visual Stimulation," "Visual Sensation" and "Visual Perception," by H. Pieron; "Binocular and Spatial Vision," by L. Opin; "Methods of Examination of the Living Eye," "Test Types" and "Trial Glasses," by P. Lemoine and G. Vallois; "Skiascopy," by H. Joseph; "Perimetry, Campimetry and Scotometry," by Dubois-Poulsen; "Tonometry," by J. Durbar; "Measures of the Pressure in the Retinal Vessels," by A. Rollin; "Application of Photography to the Eye," by J. Mawas; "Radioscopy and Radiography," by E. Hartmann; "Methods of Radioscopic Examination and Roentgenographic Examination for Intraocular Foreign Bodies," by A. Dollfus, and "Electromagnets and Sideroscopes," by P. Veil.

The high standard set by volume I is maintained in this volume, and many difficult and abstruse subjects are well handled and excellently illustrated. A pleasant feature in this volume is the introduction of portraits of the pioneer investigators. Of particular interest are the chapters on nutrition and circulation of the eye by P. Bailliar and intraocular liquid and nutrition of the globe and on ocular tension by A. Magitot.

This work is to be completed before the end of 1939.

ARNOLD KNAPP.

**Sobre a radiologia do canal optico.** By H. C. P. Marback, Bahia, Brazil. Pp. 89, with 45 plates. Bahia: Imprensa Regina, 1939.

This monograph, written as a competitive thesis, reviews the embryologic development, anatomic structure and anthropomorphic determinations of the positions of the optic canals. It mentions and

comments on the various technic (some 30 in all) employed for making roentgenograms of these structures. The author then presents his own improved technic and recommends it for general use.

In this method a cage-like device is attached to the roentgen ray tube to fit over the patient's head and hold a small film perpendicular to the primary pencil of rays. In operation the patient is seated with the head steadied on a chin support, with the Virchow plane (plane of Reid's line) corresponding to the horizontal plane. The device is placed over the head, and the tube "must be moved in such manner as to annul angles alpha and beta" of the optic canals. These angles are achieved by directing the tube downward for the angle alpha (25 degree mean) and obliquely for the angle beta (37 degree). With the tube set at these angles the device must be lined up with the patient's head, so that the primary rays strike the skull at Hartmann's point, to pass through the canal and emerge at Brunetti's point (center of the lower and outer quadrant of the orbit) to expose the film.

Marback's technic is not adaptable to routine practice and does not fill the requirements for a practical method. Too much is left to the judgment of the technician. A number of exposures are recommended by Marback for each canal. Thus true contours apparently are not consistently obtained. The method makes the projection of the canals a special procedure, several pieces of special apparatus being required. It does not allow for symmetric projection of the canals, a requirement which is essential for their comparison, for it is not enough to examine only one canal in any given case. Stereoscopic projections can scarcely be made with the technic.

RAYMOND PFEIFFER.

**Manual of the Diseases of the Eye.** By C. H. May, M.D., assisted by C. A. Perera, M. D. Edition 16. Price, \$4. Pp. 515, with 387 illustrations and 31 plates in color. Baltimore: William Wood & Company, 1939.

Dr. May's deservedly popular manual now appears in the sixteenth edition. This new edition has been carefully revised; some of the chapters have been rewritten, and new additional color plates have been added. These changes have been accomplished without any increase in size.

The book was translated into Portuguese a year ago, and it now is being translated into Urdu by the Osmania University, Hyderabad, India. This is the tenth translation into a foreign language, which is a remarkable record.

The manual is up to date and admirably fulfils its purpose of supplying a "foundation of ophthalmologic knowledge for the undergraduate student and the general medical practitioner."

ARNOLD KNAPP.

**Selected Pictures of Extraocular Affections.** By Col. R. E. Wright, I.M.S., in collaboration with Dr. R. Koman Nayar. Price, 2 rupees. Pp. 41. Madras, India: Government Press, 1938.

This book consists of a collection of pictures from the Museum of the Government Ophthalmic Hospital in Madras, India, with explanatory notes for teaching purposes. The pictures, about 90 in number, are

photographs suitable for stereoscopic observation and illustrate many conditions. Possibly those of the eyeball show up least well; the most striking are those of neoplastic conditions of the orbit. Many unusual and advanced stages are described. While mention of the frequency of any particular malady is only of relative value, it is striking to note the preponderance of epithelioblastoma over other ocular growths, while in sixteen years, 4, and surely not more than 8, melanotic sarcomas were observed. The explanatory notes conclude with an excellent and brief account of intracranial tumors, which are grouped in two classes: (1) those causing primarily atrophy of the optic nerve and (2) those causing primarily papilledema. This simple and instructive collection of pictures is a welcome addition to the list of atlases on ophthalmology.

ARNOLD KNAPP.

# Directory of Ophthalmologic Societies \*

## INTERNATIONAL

### INTERNATIONAL ASSOCIATION FOR PREVENTION OF BLINDNESS

President: Dr. P. Bailliant, 66 Boulevard Saint-Michel, Paris, 6<sup>e</sup>, France.

Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.

All correspondence should be addressed to the Secretariat, 66 Boulevard Saint-Michel, Paris, 6<sup>e</sup>, France.

### INTERNATIONAL OPHTHALMOLOGIC CONGRESS

President: Prof. Nordenson, Serafimerlasarettet, Stockholm, Sweden.

Secretary: Dr. Ehlers, Jerbanenegade 41, Copenhagen, Denmark.

### INTERNATIONAL ORGANIZATION AGAINST TRACHOMA

President: Dr. A. F. MacCallan, 33 Welbeck St., London, W., England.

## FOREIGN

### ALL-INDIA OPHTHALMOLOGICAL SOCIETY

President: Dr. B. K. Narayan Rao, Minto Ophthalmic Hospital, Bangalore.

Secretary: Dr. G. Zachariah, Flitcham, Marshall's Rd., Madras.

### BRITISH MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY

President: Dr. W. Clark Souter, 9 Albyn Pl., Aberdeen, Scotland.

Secretary: Dr. Frederick Ridley, 12 Wimpole St., London, W. 1.

### CHINESE OPHTHALMOLOGY SOCIETY

President: Dr. C. H. Chou, 363 Avenue Haig, Shanghai.

Secretary: Dr. F. S. Tsang, 221 Foochow Rd., Shanghai.

### CHINESE OPHTHALMOLOGICAL SOCIETY OF PEIPING

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.

Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.

Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

### GERMAN OPHTHALMOLOGICAL SOCIETY

President: Prof. W. Lohlein, Berlin.

Secretary: Prof. E. Engelking, Heidelberg.

### HUNGARIAN OPHTHALMOLOGICAL SOCIETY

President: Prof. H. G. Ditroi, Szeged.

Assistant Secretary: Dr. Stephen de Grosz, University Eye Hospital, Maria ucca 39, Budapest.

All correspondence should be addressed to the Assistant Secretary.

### MIDLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Niccol, 4 College Green, Gloucester, England.

Secretary: T. Harrison Butler, 61 Newhall St., Birmingham 3, England.

Place: Birmingham and Midland Eye Hospital.

### NORTH OF ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. A. MacRae, 6 Jesmond Rd., Newcastle-upon-Tyne, England.

Secretary: Dr. Percival J. Hay, 350 Glossop Rd., Sheffield 10, England.

Place: Manchester, Bradford, Leeds, Newcastle-upon-Tyne, Liverpool and Sheffield, in rotation. Time: October to April.

### OPHTHALMOLOGICAL SOCIETY OF EGYPT

President: Prof. Dr. Mohammed Mahfouz Bey, Government Hospital, Alexandria.

Secretary: Dr. Mohammed Khalil, 4 Baehler St., Cairo.

All correspondence should be addressed to the Secretary, Dr. Mohammed Khalil.

\* Secretaries of societies are requested to furnish the information necessary to make this list complete and keep it up to date.

## OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

President: Mr. T. Harrison Butler, 61 Newhall St., Birmingham 3, England.  
 Secretary: Mr. L. H. Savin, 7 Queen St., London, W. 1, England.

## OPHTHALMOLOGY SOCIETY OF BOMBAY

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4, India.  
 Secretary: Dr. H. D. Dastur, Dadar, Bombay 14, India.  
 Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

## OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. Percival J. Hay, 350 Glossop Rd., Sheffield 10, England.  
 Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.  
 Time: July 4-6, 1940.

## PALESTINE OPHTHALMOLOGICAL SOCIETY

President: Dr. Arie Feigenbaum, Abyssinian St. 15, Jerusalem.  
 Secretary: Dr. E. Sinai, Tel Aviv.

## POLISH OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.  
 Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.  
 Place: Lindley'a 4, Warsaw.

## ROYAL SOCIETY OF MEDICINE, SECTION OF OPHTHALMOLOGY

President: Dr. Malcolm Hepburn, 111 Harley St., London, W. 1, England.  
 Secretary: Dr. C. Dee Shapland, 15 Devonshire Pl., London, W. 1, England.

## SOCIETÀ OTALMOLOGICA ITALIANA

President: Prof. Dott. Giuseppe Ovio, Ophthalmological Clinic, University of Rome, Rome, Italy.  
 Secretary: Prof. Dott. Epimaco Leonardi, Via del Gianicolo, 1, Rome, Italy.

## SOCIÉTÉ FRANÇAISE D'OPHTALMOLOGIE

Secretary: Dr. René Onfray, 6 Avenue de la Motte Picquet, Paris, 7<sup>e</sup>.

## SOCIETY OF SWEDISH OPHTHALMOLOGISTS

President: Prof. K. G. Ploman, Stockholm.  
 Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö.

## TEL AVIV OPHTHALMOLOGICAL SOCIETY

President: Dr. D. Arie-Friedman, 96 Allenby St., Tel Aviv, Palestine.  
 Secretary: Dr. Sadger Max, 9 Bialik St., Tel Aviv, Palestine.

## NATIONAL

## AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.  
 Secretary: Dr. Derrick T. Vail Jr., 441 Vine St., Cincinnati.  
 Place: New York. Time: June 10-14, 1940.

## AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY, SECTION ON OPHTHALMOLOGY

President: Dr. George M. Coates, 1721 Pine St., Philadelphia.  
 Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.  
 Place: Chicago. Time: Oct. 8-13, 1939.

## AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Frederick Tooke, 1482 Mountain St., Montreal, Canada.  
 Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.  
 Place: Hot Springs, Va.

ASSOCIATION FOR RESEARCH IN OPHTHALMOLOGY, INC.

Chairman: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.  
Secretary-Treasurer: Dr. C. S. O'Brien, University Hospital, Iowa City.

CANADIAN MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY

President: Dr. S. Hanford McKee, 1528 Crescent St., Montreal.  
Secretary-Treasurer: Dr. J. A. MacMillan, 1410 Stanley St., Montreal.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.  
Secretary: Miss Regina E. Schneider, 50 W. 50th St., New York.

SECTIONAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON  
EYE, EAR, NOSE AND THROAT

President: Dr. Andrew Rados, 31 Lincoln Park, Newark.  
Secretary: Dr. William F. McKim, 317 Roseville Ave., Newark.  
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

CENTRAL WISCONSIN SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. R. O. Ebert, 104 Main St., Oshkosh.  
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. Edwin B. Goodall, 101 Bay State Rd., Boston.  
Secretary-Treasurer: Dr. Trygve Gundersen, 243 Charles St., Boston.  
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. F. C. Cordes, 384 Post St., San Francisco.  
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. J. Edward Clark, 1305-14th Ave., Seattle.  
Secretary-Treasurer: Dr. Purman Dorman, 1115 Terry Ave., Seattle.  
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. L. J. Friend, 425 E. Grand Ave., Beloit, Wis.  
Secretary-Treasurer: Dr. Thorsten E. Blomberg, 501-7th St., Rockford, Ill.  
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month from October to April, inclusive.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Don M. Howell, Alma, Mich.  
Secretary-Treasurer: Dr. Louis D. Gomon, 308 Eddy Bldg., Saginaw, Mich.  
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July and August.

SIoux VALLEY EYE AND EAR ACADEMY

President: Dr. R. A. Kelly, 304 N. Main St., Mitchell, S. D.  
Secretary-Treasurer: Dr. J. C. Decker, 515 Frances Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Grady E. Clay, Medical Arts Bldg., Atlanta, Ga.  
Secretary: Dr. John R. Hume, 921 Canal St., New Orleans.

## SOUTHWESTERN ACADEMY OF EYE, EAR, NOSE AND THROAT

President: Dr. Dake Biddle, 123 S. Stone Ave., Tucson, Ariz.

Secretary: Dr. M. P. Spearman, 1001 First National Bank Bldg., El Paso, Texas.

Place: El Paso, Texas. Time: Nov. 9-11, 1939.

## SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. Carl Wencke, Battle Creek.

Secretary-Treasurer: Dr. A. K. Zinn, Battle Creek.

Time: Third Thursday of alternate months.

## WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. C. M. Harris, Johnstown.

Secretary-Treasurer: Dr. C. Wearne Beals, 41 N. Brady St., DuBois.

## STATE

## ARKANSAS STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. Virgil Payne, Pine Bluff.

Secretary-Treasurer: Dr. Raymond C. Cook, 1005 Donaghey Bldg., Little Rock.

## COLORADO OPHTHALMOLOGICAL SOCIETY

President: Dr. Melville Black, 424 Metropolitan Bldg., Denver.

Secretary: Dr. John C. Long, 324 Metropolitan Bldg., Denver.

Place: University Club, Denver. Time: 7:30 p. m., third Saturday of each month, October to May, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR,  
NOSE AND THROAT

President: Dr. Shirley H. Baron, 309 State St., New London.

Secretary-Treasurer: Dr. S. J. Silverberg, 201 Park St., New Haven.

## EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. Grady E. Clay, 384 Peachtree St. N. E., Atlanta.

Secretary-Treasurer: Dr. J. Mason Baird, 511 Medical Arts Bldg., Atlanta.

## INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Marlow W. Manion, 23 E. Ohio St., Indianapolis.

Secretary: Dr. Edwin W. Dyar Jr., 23 E. Ohio St., Indianapolis.

Place: Indianapolis. Time: First Wednesday in April.

## IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. H. Lamb, American Bank Bldg., Davenport.

Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.

Place: Davenport.

## LOUISIANA-MISSISSIPPI OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. D. C. Montgomery, 301 Washington Ave., Greenville, Miss.

Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY  
AND OTOLARYNGOLOGY

Chairman: Dr. B. Fralick, 201 S. Main St., Ann Arbor.

Secretary: Dr. O. McGillicuddy, 124 W. Allegan St., Lansing.

## MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Frank N. Knapp, 318 W. Superior St., Duluth.

Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.

Time: Second Friday of each month from October to May.



MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. Roy Grigg, Bozeman.

Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY,  
OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. James S. Shipman, 542 Cooper St., Camden.

Secretary: Dr. Wright McMillan, 23 Passaic Ave., Passaic.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. Algernon B. Reese, 73 E. 71st St., New York.

Secretary: Dr. Chester C. Cott, 333 Linwood Ave., Buffalo.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. F. C. Smith, 106 W. 7th St., Charlotte.

Secretary-Treasurer: Dr. M. R. Gibson, Professional Bldg., Raleigh.

Place: Statesville: Time: Sept. 21, 1939.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. N. A. Youngs, 322 De Mers Ave., Grand Forks.

Secretary-Treasurer: Dr. F. L. Wicks, 516-6th St., Valley City.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. L. O. Clement, 406 State St., Salem.

Secretary-Treasurer: Dr. Paul Bailey, 833 S. W. 11th Ave., Portland.

Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.

Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.

Place: Rhode Island Medical Society Library, Providence. Time: 8:30 p. m.,  
second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. S. B. Fishburne, 1430 Marion St., Columbia.

Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. J. B. Stanford, 899 Madison Ave., Memphis.

Secretary-Treasurer: Dr. W. D. Stinson, 124 Physicians and Surgeons Bldg.,  
Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. A. N. Champion, 705 E. Houston St., San Antonio.

Secretary: Dr. Dan Brannin, 1719 Pacific Ave., Dallas.

Place: Houston. Time: December 1939.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.

Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.

Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Charles T. St. Clair, 418 Bland St., Bluefield, W. Va.

Secretary-Treasurer: Dr. M. H. Williams, 30½ Franklin Rd. S. W., Roanoke.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE  
AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.

Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

## LOCAL

## AKRON ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. E. Brown, Second National Bldg., Akron, Ohio.  
Secretary-Treasurer: Dr. C. R. Anderson, 106 S. Main St., Akron, Ohio.  
Time: First Monday in January, March, May and November.

## ATLANTA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Arthur G. Fort, 478 Peachtree St. N. E., Atlanta, Ga.  
Secretary: Dr. Lester A. Brown, 478 Peachtree St. N. E., Atlanta, Ga.  
Place: Grady Hospital. Time: 6:00 p. m., second Wednesday of each month from October to May.

## BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Frank B. Walsh, Wilmer Institute, Johns Hopkins Hospital, Baltimore.  
Secretary: Dr. Fred M. Reese, 6 E. Eager St., Baltimore.  
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

## BIRMINGHAM EYE, EAR, NOSE AND THROAT CLUB

President: Each member, in alphabetical order.  
Secretary: Dr. N. E. Miles, 408 Medical Arts Bldg., Birmingham, Ala.  
Place: Tutwiler Hotel. Time: 6:30 p. m., second Tuesday of each month, September to May, inclusive.

## BROOKLYN OPHTHALMOLOGICAL SOCIETY

President: Dr. E. Clifford Place, 59 Livingston St., Brooklyn.  
Secretary-Treasurer: Dr. Frank Mallon, 1135 Park Pl., Brooklyn.  
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

## BUFFALO OPHTHALMOLOGIC CLUB

President: Dr. James G. Fowler, 412 Linwood Ave., Buffalo.  
Secretary-Treasurer: Dr. Sheldon B. Freeman, 196 Linwood Ave., Buffalo.  
Time: Second Thursday of each month.

## CHATTANOOGA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Each member, in alphabetical order.  
Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga, Tenn.  
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

## CHICAGO OPHTHALMOLOGICAL SOCIETY

President: Dr. Georgiana Dvorak-Theobald, 715 Lake St., Oak Park, Ill.  
Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.  
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

## CINCINNATI OPHTHALMIC CLUB

Chairman: Each member, in rotation.  
Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.  
Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

## CLEVELAND OPHTHALMOLOGIC CLUB

Chairman: Dr. Albert J. Ruedemann, Cleveland Clinic, Cleveland.  
Secretary: Dr. G. Leslie Miller, 14805 Detroit Ave., Cleveland.  
Time: Second Tuesday in October, December, February and April.

COLLEGE OF PHYSICIANS, PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.  
 Clerk: Dr. W. S. Reese, 1901 Walnut St., Philadelphia.  
 Time: Third Thursday of every month from October to April, inclusive.

COLUMBUS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

Chairman: Dr. Harry M. Sage, 9 Buttles Ave., Columbus, Ohio.  
 Secretary-Treasurer: Dr. Hugh C. Thompson, 289 E. State St., Columbus, Ohio.  
 Place: The Neil House. Time: 6 p. m., first Monday of each month.

CORPUS CHRISTI EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Edgar G. Mathis, 416 Chaparral St., Corpus Christi, Texas.  
 Secretary: Dr. E. King Gill, 416 Chaparral St., Corpus Christi, Texas.  
 Time: Second Thursday of each month from October to May.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Maxwell Thomas, Medical Arts Bldg., Dallas, Texas.  
 Secretary: Dr. J. Dudley Singleton, 1719 Pacific Ave., Dallas, Texas.  
 Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

DES MOINES ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.  
 Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.  
 Time: 7:45 p. m., third Monday of every month from September to May.

DETROIT OPHTHALMOLOGICAL CLUB

Chairman: Members rotate alphabetically.  
 Secretary: Dr. Arthur S. Hale, 1609 Eaton Tower, Detroit.  
 Time: 6:30 p. m., first Wednesday of each month.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. L. A. Hulsebosch, 191 Glen St., Glen Falls.  
 Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.  
 Time: Third Wednesday in October, November, March, April, May and June.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. R. A. Gough, 602 W. 10th St., Fort Worth, Texas.  
 Secretary-Treasurer: Dr. Charles R. Lees, 806 Medical Arts Bldg., Fort Worth, Texas.  
 Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

GRAND RAPIDS EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.  
 Secretary-Treasurer: Dr. Robert G. Laird, 116 E. Fulton St., Grand Rapids, Mich.  
 Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

HOUSTON ACADEMY OF MEDICINE, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. Louis Daily, 1215 Walker Ave., Houston, Texas.  
 Secretary: Dr. Herbert H. Harris, 1004 Medical Arts Bldg., Houston, Texas.  
 Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

## INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. W. Rutherford, 23 E. Ohio St., Indianapolis.

Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.

Place: Indianapolis Athletic Club. Time: 6:30 p. m., second Thursday of each month from November to June.

## KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. E. N. Robertson, Concordia, Kan.

Secretary: Dr. John S. Knight, 1103 Grand Ave., Kansas City, Mo.

Time: Third Thursday of each month from October to June. The November, January and March meetings are devoted to clinical work.

## LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.

Secretary-Treasurer: Dr. Paul Nilsson, 211 Cherry Ave., Long Beach, Calif.

Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

## LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.

Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.

Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:00 p. m., fourth Monday of each month from September to May, inclusive.

## LOUISVILLE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Gaylord C. Hall, Brown Bldg., Louisville, Ky.

Secretary-Treasurer: Dr. Charles K. Beck, Starks Bldg., Louisville, Ky.

Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF  
OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Earle Breeding, 1801 I St. N. W., Washington.

Secretary: Dr. Elmer Shepherd, 1606-20th St. N. W., Washington.

Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

## MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.

Secretary: Dr. Sam H. Sonders, Medical Arts Bldg., Memphis, Tenn.

Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

## MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. John E. Mulsow, 231 W. Wisconsin Ave., Milwaukee.

Secretary-Treasurer: Dr. John B. Hitz, 411 E. Mason St., Milwaukee.

Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

## MINNEAPOLIS OPHTHALMOLOGICAL SOCIETY

Chairman: Each member, in alphabetical order.

Secretary: Dr. M. C. Pfunder, 645 Medical Arts Bldg., Minneapolis.

Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

## MONTGOMERY COUNTY MEDICAL SOCIETY

Chairman: Dr. H. V. Dutrow, 1040 Fidelity Medical Bldg., Dayton, Ohio.

Secretary-Treasurer: Dr. Maitland D. Place, 981 Reibold Bldg., Dayton, Ohio.

Place: Van Cleve Hotel. Time: 6:30 p. m., first Tuesday of each month from October to June, inclusive.

MONTREAL OPHTHALMOLOGICAL SOCIETY

President: Dr. L. de G. Joubert, 690 Dunlop St., Montreal, Canada.  
Secretary: Dr. K. B. Johnston, 1509 Sherbrooke St. W., Montreal, Canada.  
Time: Second Thursday of October, December, February and April.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Guy Maness, 119-7th Ave., Nashville, Tenn.  
Secretary-Treasurer: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.  
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

NEW HAVEN OPHTHALMOLOGICAL SOCIETY

President: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.  
Secretary: Dr. Frederick A. Wies, 255 Bradley St., New Haven, Conn.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. E. G. Walls, 619 Maison Blanche Bldg., New Orleans.  
Secretary-Treasurer: Dr. W. B. Clark, 1012 American Bank Bldg., New Orleans.  
Place: Louisiana State University Medical Bldg. Time: 8 p. m., second Tuesday of each month from October to June.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. James W. White, 15 Park Ave., New York.  
Secretary: Dr. Rudolf Aebli, 30 E. 40th St., New York.  
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

President: Dr. Arthur M. Yudkin, New York.  
Secretary: Dr. Benjamin Esterman, 515 Park Ave., New York.  
Place: Squibb Hall, 745-5th Ave. Time: 8 p. m., first Monday of each month from October to May, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND  
OTO-LARYNGOLOGICAL SOCIETY

President: Dr. J. T. Maxwell, 1140 Medical Arts Bldg., Omaha.  
Secretary-Treasurer: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.  
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

PASSAIC-BERGEN OPHTHALMOLOGICAL CLUB

President: Dr. R. N. Berke, 430 Union St., Hackensack, N. J.  
Secretary-Treasurer: Dr. T. A. Sanfacon, 340 Park Ave., Paterson, N. J.  
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

PHILADELPHIA COUNTY MEDICAL SOCIETY, EYE SECTION

Chairman: Dr. Walter I. Lillie, 255 S. 17th St., Philadelphia.  
Secretary: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.  
Time: First Thursday of each month from October to May.

PITTSBURGH OPHTHALMOLOGICAL SOCIETY

President: Dr. Adolph Krebs, 509 Liberty Ave., Pittsburgh.  
Secretary: Dr. George H. Shuman, 351-5th Ave., Pittsburgh.  
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

RICHMOND OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Rudolph Thomason, Professional Bldg., Richmond, Va.  
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.  
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

## ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Edwin S. Ingersoll, 26 S. Goodman St., Rochester, N. Y.  
Secretary-Treasurer: Dr. Charles T. Sullivan, 277 Alexander St., Rochester, N. Y.  
Place: Rochester Academy of Medicine, 1441 East Ave. Time: 8 p. m., second Wednesday of each month from September to May.

## ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. B. Y. Alvis, Carleton Bldg., St. Louis.  
Secretary: Dr. Carl C. Beisbarth, 3720 Washington Blvd., St. Louis.  
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

## SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Oscar H. Judkins, 414 Navarro St., San Antonio, Texas.  
Secretary-Treasurer: Dr. Wilfred E. Muldoon, 414 Navarro St., San Antonio, Texas.  
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE,  
EAR, NOSE AND THROAT

Chairman: Dr. Russell Fletcher, 490 Post St., San Francisco.  
Secretary: Dr. Avery Morley Hicks, 490 Post St., San Francisco.  
Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except May, June, July and December.

## SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. R. R. Kirkpatrick, 6th and Walnut Sts., Texarkana, Ark.  
Secretary-Treasurer: Dr. W. L. Atkins, 940 Margaret Pl., Shreveport, La.  
Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

## SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Walter W. Henderson, 407 Riverside Ave., Spokane, Wash.  
Secretary: Dr. Robert L. Pohl, 407 Riverside Ave., Spokane, Wash.  
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

## SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. James F. Cahill, 428 S. Salina St., Syracuse, N. Y.  
Secretary-Treasurer: Dr. I. Herbert Katz, 713 E. Genesee St., Syracuse, N. Y.  
Place: University Club. Time: First Tuesday of each month except June, July and August.

## TORONTO ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. W. R. F. Luke, 316 Medical Arts Bldg., Toronto, Canada.  
Secretary: Dr. W. T. Gratton, 216 Medical Arts Bldg., Toronto, Canada.  
Place: Academy of Medicine, 13 Queens Park. Time: First Monday of each month, November to April.

## WASHINGTON, D. C., OPHTHALMOLOGICAL SOCIETY

President: Dr. Ernest Sheppard, 927 Farragut Sq. N. W., Washington, D. C.  
Secretary-Treasurer: Dr. E. Leonard Goodman, 1801 I St. N. W., Washington, D. C.  
Place: Episcopal Eye and Ear Hospital. Time: 7:30 p. m., first Monday in November, January, March and April.

## LOCAL USE OF VITAMIN A PREPARATIONS IN OPHTHALMIC PRACTICE

STEPHEN DE GRÓSZ, M.D.

BUDAPEST, HUNGARY

The local application of vitamin A is of greater significance in the field of ophthalmology than is oral or intramuscular administration. In moderate climates this method of application of vitamin A does not extend to the general avitaminoses (keratomalacia and similar diseases). Such conditions are rare in Hungary. The aspecific action of this vitamin consists of epithelization and protection of the epithelium. It is not impossible that some conditions which respond to this form of therapy are due to local vitamin deficiency without being a general avitaminosis. It has always been a custom among laymen to apply milk and butter to the eye for the treatment of various ocular diseases irrespective of their etiology; nevertheless, such treatment must now be considered as local vitamin therapy, although sometimes it is falsely indicated. The mysterious cure of Tobias' disease (serpent ulcer?), which was effected by the local application of fish liver, may be also considered due to vitamin A therapy, though some authors claimed that the cure was due to the destruction of pneumococci by bile salts. The local application of vitamin A was first undertaken by Russian observers. Balachovski, of Rostov, called attention to the importance of local vitamin deficiency. One may assume that some pathologic organs require more vitamin A and that therefore a local deficiency develops. Balachovski was the first to experiment with colloidal carotene in oil. Other Russian investigators also worked with provitamin A.<sup>1</sup> They obtained good results with the treatment of phlyctenular keratoconjunctivitis, various types of keratitis (superficial, photoelectric and deep keratitis, dendritic ulcer, marginal infiltration and pannus), corneal erosions, trachoma, scleritis, blepharitis

From the Eye Clinic of the University of Budapest.

1. Balachovski, S.: *Sur la possibilité d'insuffisances locales en vitamines*, Presse méd. **42**:1404, 1934. Kaptsovskaya, R. S.: *Clinical Characteristics of Carotene Used in Treatment of External Diseases of the Eye*, Sovet. vestnik oftal. **5**:242, 1934. Rachevskij, F. A.: *Provitamin A as Anti-Inflammatory Factor in Diseases of the Eye*, *ibid.* **4**:470, 1934; abstracted, *Physiologische und therapeutische Wirkung von Kolloidallösungen des Provitamins A bei dessen lokaler Anwendung am Auge*, Klin. Wchnschr. **13**:918, 1934.

and chronic catarrh. The therapy was useless in cases of acute catarrh and serpent ulcer. Provitamin A when applied several times a day accelerates the healing process and has an exceptional analgesic effect. It does not have any effect on the vascular system or any bactericidal action. Balachovski advised the use of carotene for other conditions (rhagades and gingivitis). According to Orloff, this preparation is extremely useful after keratoplasty. This field of application was discussed in detail by Towbin<sup>2</sup> from an experimental point of view; Villard,<sup>3</sup> with another vitamin A solution, obtained transparent disks. Successful results can be obtained with carotene in the treatment of chemical or thermic burns of the eye (Pashkovskij<sup>4</sup>) and of herpetic diseases (Meshcherskij<sup>5</sup>). Cod liver oil, which was first introduced into surgical practice by Löhr for the treatment of purulent wounds, was used for various diseases of the eye long ago, especially for trophic conditions. Recently Stevenson<sup>6</sup> reported on its effect; he mentioned keratitis due to mustard gas (dichlorethyl sulfide) as among the conditions for which it is indicated. Objections are raised to its use because of the irritant substances it contains (acids and aldehydes) and its unpleasant odor. However, besides vitamin A, vitamin D is also present; according to some authors this is a valuable combination. Federici<sup>7</sup> also recommended the use of cod liver oil, which he considered more effective than synthetic vitamin preparations. Though the synthetic preparations have epithelizing power, nevertheless the neutral refined cod liver oil (2,750 international units of vitamin A and 200 international units of vitamin D) surpasses them in this respect. These facts were proved with experimental corneal lesions of animals. Rinaldi<sup>8</sup> also experimented with the combination of vitamins A and D and obtained good results in the treatment of staphylococcic corneal infection. Twenty patients were treated with a vitamin A and D preparation (adexolin) which sometimes causes blepharitis in sensitive persons. Rinaldi treated patients with corneal ulcer, trachoma, phlyctenular keratitis and inter-

2. Towbin, B. G.: Ein Versuch der Carotinverwendung bei Hornhautverpflanzung, *Ztschr. f. Augenh.* **88**:107, 1936.

3. Villard, H.; Viallefont, H., and Diacono, E.: Greffe de la cornée chez le lapin et vitamine A, *Arch. Soc. d. sc. méd. et biol. de Montpellier* **16**:423, 1935.

4. Pashkovskij, V. M.: Effect of Carotene in Certain External Diseases of the Eye, *Sovet. vestnik oftal.* **7**:500, 1935.

5. Meshcherskij, N. N.: Carotene in the Therapy of Herpetic Keratitis, *Vestnik oftal.* **10**:419, 1937.

6. Stevenson, E.: Cod Liver Oil as a Local Treatment for External Affections of the Eyes, *Brit. J. Ophth.* **20**:416, 1936.

7. Federici, E.: Le vitamine A e D nei processi di riparazione della cornea (studio sperimentale), *Boll. d'ocul.* **16**:357, 1937.

8. Rinaldi, S.: Le vitamine A e D nel trattamento locale di lesioni corneali (ricerche sperimentali e cliniche), *Ann. di ottal. e clin. ocul.* **64**:505, 1936.



stitial keratitis. Clausen<sup>9</sup> used unguentolan eye ointment, a cod liver oil preparation, with success, especially in the treatment of caustic burns. Sometimes irritation developed in sensitive persons. The original ointment was suggested for herpes and neuroparalytic keratitis. Villard and his co-workers<sup>10</sup> reported the case of a 66 year old woman with positive Wassermann reaction in which a torpid ulcer was cured in a short time by daily instillations of cod liver oil and vitamin A.

Heinsius<sup>11</sup> proved by experiments on animals that cod liver oil accelerates the regeneration of artificial corneal abrasions just as well as vitamin A in oil. There is no fundamental difference in regard to the epithelization produced by these two preparations; however, it can be said that this power belongs to vitamin A and not to vitamin D. It is interesting that a concentrated solution of vitamin A retards the formation of epithelium. Heinsius followed the method of Löhlein for recording the action of thorium x on the eye. This experiment gives information only as to the formation of epithelium, in contrast to other authors' experiments (Drigalski and Lauber), which pertain only to connective tissue. Heinsius also used a vitamin A ointment (2 per cent vogan) one to three times daily. Indications for its use are on the whole the same as those previously mentioned.

At the Frankfort Eye Hospital a vitamin A ointment or oil (20 per cent vogan) is used for the treatment of trophic ulcers and burns (Thiel). Viallefont and Diacono<sup>12</sup> and also Vanýsek<sup>13</sup> administered vitamin A regularly in cases of phlyctenular diseases. I wish to call attention to Kentgens' <sup>14</sup> important work. He found low values for vitamin A in the serum of patients with corneal diseases. The value of combined general and local vitamin A therapy is proved by the shortening of the duration of these diseases, which include herpes, superficial punctate keratitis, scrofulous keratoconjunctivitis, rodent ulcer and gonorrheal ulcer.

9. Clausen: Demonstrationen (case 23), *Klin. Monatsbl. f. Augenh.* **96**:524, 1936. Romeick, in discussion on Clausen, p. 526.

10. Villard, H.; Viallefont, H., and Diacono, E.: Kératite ulcéreuse trophique guérie par vitaminothérapie locale, *Arch. Soc. d. sc. méd. et biol. de Montpellier* **16**:302, 1935.

11. Heinsius, E.: Experimentelle Untersuchungen über den Einfluss des Vitamin A auf die Regeneration des Hornhautepithels, *Arch. f. Ophth.* **136**:103, 1937; Lokale Verwendung von Vitamin-A-haltigen Salben in der Augenheilkunde, *Klin. Monatsbl. f. Augenh.* **98**:246, 1937.

12. Viallefont, H., and Diacono, E.: Le rôle des vitamines en ophtalmologie, *Arch. d'opht.* **52**:723, 1935.

13. Vanýsek, J.: Bedeutung des Vitamins A bei der Regeneration von Hornhautgewebe, *Českoslov. oftal.* **3**:189, 1937.

14. Kentgens, S. K.: Ueber Vitamin-A-Therapie bei Hornhauterkrankungen, *Ophthalmologica* **96**:3, 1938.

## AUTHOR'S OBSERVATIONS

For years a vitamin A preparation called vulnovitan<sup>15</sup> (an oil with a liquid petrolatum base or an ointment with a petrolatum base) has been used by my co-workers and me for routine treatment at the dispensary of the ophthalmic clinic of the University of Budapest. One cubic centimeter of oil contains 1,000 international units of vitamin A. The oil is yellow and odorless and is distributed in ampules of 2 and 10 cc. and in bottles of 50 cc.

Horn and Sándor<sup>16</sup> have discussed its use in cases of phlegmon, tendovaginitis, etc.; in such cases the oil is poured over the incision. It does not cause irritation, it speeds granulation, it stops secondary infection and it helps eliminate necrotic tissue. I do not wish to discuss in detail the histories of the cases in which this preparation was used because there are no two in which the picture was exactly similar and other therapeutic agents were also employed. Instead of mentioning statistical data of dubious value, I prefer to describe the pathologic processes for which the application of vitamin A seems to be correct. As far as injuries are concerned, this therapy is extremely useful in promoting epithelization of fresh corneal lesions, for example, erosions after the extraction of foreign bodies; it has a powerful analgesic effect, though it does not surpass ethylmorphine hydrochloride. Naturally we do not neglect bandaging of the eye. For injuries of the eyelid for which sutures are not necessary, we use the ointment (1 Gm. contains 500 international units of vitamin A). Other conditions for which the ointment is indicated are torpid ulcerous blepharitis and scrofulous blepharitis, though for the former a better reaction is obtained with roentgen irradiation. Though the lack of vitamin A creates a disposition to infection, it is worth while mentioning the fact that one cannot expect the anti-infectious factor of vitamin A to have a disinfecting action since it is not bactericidal; nevertheless, there is a rise of local resistance. However, if we fear the possibility of infection or if signs of infection are already present (corneal infiltration or optic activity of the aqueous), then it is necessary to apply disinfecting agents (acridine dye or ethylhydrocupreine hydrochloride) and to inject foreign protein (milk) or sulfanilamide. Furthermore, it seems that the vitamin A preparation has a good effect on injuries and burns of the conjunctiva, for after thorough rinsing of the cul-de-sac its application prevents the formation of adhesions by hastening epithelization of the conjunctiva.

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15. This product is prepared by Messrs. Gedeon Richter, Ltd., Budapest.

16. (a) Horn, Z., and Sándor, I.: Local Application of Vitamin A in Therapy of Wounds, *Orvosi hetil.* 78:261, 1934. (b) Sándor, I.: Vitamin A (Vulnovitan) in the Local Treatment of Wounds, *ibid.* 80:505, 1936.

I should like to mention that in cases of extensive burns of the conjunctiva or in cases in which the cornea becomes opaque the early transplantation of buccal mucous membrane according to the method of Denig is today considered a useful procedure (Thies and Csapody). At the clinic we used vulnovitan (oil) for the treatment of caustic burns caused by lime and sodium hydroxide and also for injuries caused by indelible pencil, the eye first being rinsed with a 1 per cent solution of hydrogen peroxide. Vulnovitan is absolutely indicated for injuries due to gases used in industry and in warfare because of its analgesic and lubricating effect.

Ferenczy<sup>17</sup> recommended drainage with vulnovitan (oil) in cases of acute dacryocystitis after the incision was made. He also obtained good results in cases of ulcerative blepharitis. Personally, I did not try the preparation for such conditions.

I have tried applying vitamin A for different types of corneal inflammation every time the epithelium showed sluggish regeneration or regeneration did not occur. I have also used it whenever a trophic disturbance was suspected, for example, for torpid ulcers which are due to senile or rosaceous factors, for recurrent erosion and bullous keratitis; the last two conditions belong to the herpetic group of diseases, which, according to my opinion, represents the most important indication for vitamin A. Though herpetic diseases are due to a filtrable virus, the antiseptic drugs have no effect. The epithelium is loosened by the first movement of the eyelid and is torn off with great pain in the morning; this is prevented by instilling vitamin A in oil at night, which lubricates the cornea. Short wave therapy<sup>18</sup> and vitamin B<sub>1</sub><sup>19</sup> also have a favorable effect on herpetic diseases. I do not deny the fact that in cases of more serious involvement the chemical destruction of diseased tissues by iodine, ionization with zinc and abrasion, or rather cauterization, of the ulcer may change the course of this long and painful disease. Neuro-paralytic keratitis also has its important indications. I saw an excellent example of this in a case in which after alcoholization of the gasserian ganglion severe keratitis developed. Different sorts of drugs were tried, but it was only after systematic application of vitamin A in oil and a bandage that signs of epithelization were evident. This calls to mind Mellanby's<sup>20</sup> theory concerning the trophic fibers (sympathetic?). This

17. Ferenczy, Z., cited by Sándor.<sup>16b</sup>

18. von Grósz, S.: Short-Wave Therapy in Ophthalmology, *Orvosképzés* **27**: 94, 1937.

19. von Grósz, S.: Bedeutung der B-Vitamine in der Augenheilkunde, *Arch. f. Ophth.* **140**:149, 1939.

20. Mellanby, E.: Durch mangelhafte Ernährung bedingte Erkrankungen des Nervensystems, *Schweiz. med. Wchnschr.* **67**:349, 1936.

theory may also be applied to herpes zoster ophthalmicus. In addition to these conditions, the therapy may be tried for Fuchs's epithelial dystrophy, for filamentous keratitis and for some types of corneal degeneration of obscure etiology.<sup>21</sup> Filamentous keratitis is due to dryness of the eye and represents a part of Sjögren's syndrome<sup>22</sup> (dry mouth and arthritis deformans of the small joints of women at the climacteric). In the aforementioned diseases the corneal sensitivity is more or less impaired.<sup>23</sup> The application of the preparation is practical for acute photophobia after pontocaine and epinephrine hydrochloride are dropped into the eye. I recommend vitamin A in oil for superficial punctate keratitis which is produced by various chemical agents, such as are employed in the manufacture of rayon, furniture varnish and chemicals. Other conditions for which it is indicated are radium necrosis of the cornea, described by Martin,<sup>24</sup> and keratitis due to mustard gas; the outstanding symptoms of the latter are recurrent ulcer and a white conjunctiva with purple red varicosities of the vessels (Genet).

French and Russian authors recommend local therapy with vitamin A for phlyctenular keratitis. I cannot give an opinion in this regard. However, I should like to emphasize that for this condition general vitamin therapy is of greater importance than local therapy, which can be employed only in the reparative stage of the ulcer. We also applied vulnovitan in cases of trachomatous pannus. It is almost impossible to evaluate the result because of the chronic character of the condition. It is not advisable to apply vitamin A in oil for serpent ulcer as it may hasten the sloughing; therefore, if one wants to use it at all one should do so only at a later stage.

There is no indication for vitamin A therapy for acute or chronic catarrh, scleritis or deep keratitis.

Recently we applied vitamin E in oil in cases of seborrheic blepharitis. No conclusion can be drawn so far as to its value.

By way of review, the indications for the local application of vitamin A are presented in the following outline:

A. Lid (ointment)

1. Chronic eczema; ulcerative scrofulous blepharitis
2. Injuries (burns, wounds, etc.)

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21. Hanke, V.: Die degenerativen und neurotrophen Hornhauterkrankungen. *Zentralbl. f. d. ges. Ophth.* **36**:465, 1936.

22. von Grósz, S.: Aetiologie und Therapie der Keratoconjunctivitis sicca, *Klin. Monatsbl. f. Augenh.* **97**:472, 1936.

23. Cerise, L., and Thurel, R.: L'anesthésie pathologique de la cornée, Tours. Arrault & Cie, 1931.

24. Martin, P.: Effects of Irradiation of the Eye by Radium, *Tr. Ophth. Soc. U. Kingdom* **53**:246, 1933.

## B. Cornea and conjunctiva (oil)

1. Burns (chemical and thermic) and fresh wounds
2. Acute photo-ophthalmia
3. Herpes of the cornea (dendritic ulcer, recurrent erosion and keratitis bullosa)
4. Neurotrophic conditions (neuroparalytic keratitis), gonorrheal ulcer and Mooren's ulcer
5. Dystrophies (filiformis, etc.) and degenerations
6. Superficial punctate keratitis (industrial)
7. Injuries due to gas (warfare and industrial)
8. Keratitis due to lagophthalmos, xeroses (trachoma, pemphigus and essential shrinkage of the conjunctiva)
9. Postoperative treatment of keratoplasty
10. Phlyctenular keratoconjunctivitis (combined with general use of vitamin A)

## MODE OF ACTION

As has been seen in many animal experiments and in man, local application of vitamin A not only helps but accelerates epithelization; it is truly a protective agent for the epithelium. This protection may be pictured in the following manner: vitamin A consists of compounds necessary for the production of cells, especially those of the nucleus; most likely purine bodies (nucleoproteids and nucleinic acid) play the important part. The rise of the resistance is only a secondary phenomenon (von Euler). The complicated biochemical happenings can be explained only by microphysiologic experiments on the cell. To eliminate the opposite reaction, overdosage must be avoided. I should advise that one secure vitamin A in oil in small amounts (ampules), because, owing to its unstableness, it readily loses its effectiveness, due to oxidation, once the container is opened.

The excipient itself also has adhesive and protective characteristics. There have been a number of animal experiments which prove that drops of the oil themselves represent a beneficial factor; nevertheless, the curative effect can be attributed to vitamin A. However, the use of ethylmorphine hydrochloride is not superfluous when one is applying vitamin A.

## CONCLUSION

One can readily see that the local application of vitamin A is an appropriate method for the treatment of various external diseases of the eye. Vitamin A is applied from three to five times a day and can be used with or without bandage; a supplementary treatment can be given also. Heat in the form of short wave irradiation and infra-red irradiation should be given to aid resorption of vitamin A. It is hoped that the use of this vitamin locally in the field of ophthalmology will expand rap-

idly. The combination of the local with the general (oral) use of vitamin A is substantiated by the low vitamin A values found in the serum of persons with some types of corneal disease (Kentgens).

#### SUMMARY

A detailed account of the local application of vitamin A has been given. The indications are discussed in full detail. On account of its favorable epithelization effect, it possesses a large field in ocular therapeutics; it represents an outstanding therapeutic agent especially for injuries and trophic conditions of the cornea.

# TREATMENT OF TUBERCULOSIS OF THE ANTERIOR PORTION OF THE EYE WITH BETA RAYS OF RADIUM

ALAN C. WOODS, M.D.

BALTIMORE

In a paper on the treatment of ocular tuberculosis, written with Dr. Randolph in 1937, mention was made of the therapeutic use of the beta rays of radium, and it was stated that such treatment appeared of decided promise. This method of treatment was made available through the agency of Dr. Curtis F. Burnam, of the Howard A. Kelly Hospital, who devised the particular applicator used in 1927 and since that time has used it in the treatment of various ocular conditions. In fact, as early as 1934 Dr. Burnam had treated several patients with tuberculous keratitis with beta irradiation. A full report on beta irradiation will be made later by Dr. Burnam. The purpose of this paper is to give a preliminary report of such therapy for tuberculosis of the anterior portion of the eye, to which it appears singularly applicable.

When radioactive elements disintegrate, energy is liberated in the form of rays. There are three different rays in radium emanation, the alpha, the beta and the gamma rays. The alpha rays are positively charged helium atoms and comprise about 92 per cent of the total rays given off. They have a minimum penetration, are absorbed by glass or by paper and have no therapeutic value. The beta rays are negatively charged ions and have relatively low penetrative power, penetrating tissue only about 2 mm. and being completely absorbed by either 1 mm. of lead or 2 mm. of brass. They are not homogeneous but consist of separate homogeneous bundles with different energies and different penetrating powers. Gamma rays, usually employed alone in radium therapy, are uncharged particles analogous to the particles of ordinary light and roentgen rays. They have a high penetrative power, even for the densest of materials. Seven per cent of the rays remain after passing through 10 cm. of lead.

The beta irradiation employed in the treatment of the patients considered here was used in the form of radium emanation or radon. At the Howard A. Kelly Hospital, the gas liberated from slightly over 5 Gm. of radium salt in solution is pumped off and sealed in an ordinary soda glass bulb of about 1 mm. thickness, and this in turn is screened

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From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital.

in a brass applicator open at one end over a diameter of about 4 mm. to allow application of the radon. Since a radium salt in solution yields about one sixth of the total radon possible from such a preparation each day, the beta applicator as originally prepared may contain as much as 800 millicuries. This radon begins to disintegrate as soon as it is pumped off, the output of rays increasing for the first three hours and thereafter decreasing. The contents of the bulb are therefore measured at the end of three hours, and at any definite time thereafter the content is easily determinable because the rate of disintegration is uniform per unit of time.

When the limited penetration of beta rays is considered, it is evident that in the eye its use is limited to treatment of the cornea, sclera and possibly the peripheral portions of the iris. Its especial applicability to diseases of the anterior portion of the eye was mentioned in 1929 by Kumer and Sallmann, who regretted that it was impossible to use it because there were few beta applicators in the world and because the usual radium caches were of insufficient size to make such use economic or indeed possible.

#### METHOD OF TREATMENT

The eye is anesthetized with a local anesthetic, and the applicator is applied just short of actual contact with the globe to the area to be treated. Since the effect is limited to the actual area of the eye irradiated, multiple areas may be treated at any one time without fear of cumulative effect. Since the beta rays have low penetrative power, none of them reach the lens, and in none of the patients treated thus far, some over a period of five years, has any damage to the lens been observed. Likewise, there has not been observed any activation of the uveal inflammation or local exacerbation in the keratitis in the patients with tuberculous keratoiritis or scleritis. In fact, the only ocular reaction to beta irradiation thus far observed occurred in a patient with a blind eye, who was given a large dose for an entirely distinct condition of the lids. Here the reaction was a persistent superficial punctate keratitis.

#### DOSAGE

The amount of radium given therapeutically depends on the distance from which the radium is applied and on the area covered. The dosage here outlined applied only to the one area treated. Multiple areas on the same eye or the same cornea may be treated at one sitting.

The skin erythema dose of the beta rays, emanation from the radon with the applicator, at just short of actual contact, is 1 Gm. for twenty seconds. The skin erythema dose of the gamma rays, which also emanate from the applicator, is about 1 Gm. for eight minutes. It is obvious, therefore, that when a 60 per cent skin erythema dose of beta irradiation is given the patient receives only about 2 per cent of the



skin erythema dose of the gamma rays. This ratio permits full therapeutic doses of the weakly penetrating beta rays, while only a negligible amount of the highly penetrating gamma rays is given.

When patients with tuberculous keratoiritis were first treated, extremely small doses of about 1 Gm. for three seconds to one area every three weeks were given for fear of activation of the disease or damage to the lens. As a greater number of patients were treated, it became evident that these fears were groundless. However, the full irritative effect of the irradiation may not be evident for two weeks. Therefore, when larger doses are given, such as 1 Gm. for twelve seconds, approximately 60 per cent of the skin erythema dose, the interval between treatments is never less than two weeks. With smaller doses, such as 1 Gm. for five seconds, treatments may be given weekly or even twice weekly.

No hard and fast rules can be given for the total dose. It depends entirely on the condition treated and the response to treatment. In general, in one course of treatment over one area a total dose of 1 Gm. for thirty-five to forty seconds is given, distributed over four to six weeks. When this dose has been attained, treatment is usually remitted for several months to avoid possible cumulative effect.

### RESULTS

To date 15 patients with active tuberculosis of the cornea, iris and sclera have been treated with beta irradiation. Two of these patients had received only two treatments when they disappeared from observation. The results for the remaining 13 are shown in the accompanying tables.

Ten patients had tuberculous keratoiritis. In each of these patients all evidences of active inflammation disappeared by the time the first course of treatments was completed. Two of the patients, however, had recurrences. One patient, with involvement of each eye at different times, had two recurrences in the right eye, both of which again healed after further irradiation. This patient had three recurrences in the left eye, each time coincident with the onset of the menstrual cycle. A diagnostic dilatation and curettage showed, however, a normal endometrium, and the attack subsided after further irradiation. The second patient had a recurrence three months after completion of the final course, and again inflammation subsided after a second course of irradiation. A summary of the data on these cases is shown in table 1.

The remaining 3 patients had deep tuberculous scleritis. These patients responded to treatment much slower than those with keratoiritis, steady treatment over a longer period being required before a therapeutic effect was observed. Nevertheless, the results were encouraging. One patient showed improvement and final healing of the

scleritis after steady treatment over eight months. The second patient, whose eye was blind with an atrophic choroiditis, had a marked scleral ectasia at the site of the scleritis. Under repeated courses of beta irradiation, extending over two years, there was marked and steady improvement with almost complete subsidence of the ectasia. This patient had been under observation for the preceding five years and had grown steadily worse in spite of all local and general treatment, including repeated paracentesis and tuberculin therapy. The third patient showed

TABLE 1.—*Effect of Beta Irradiation in Cases of Active Tuberculous Keratoiritis*

| Case | Vision at Initiation of Treatment       | Mode of Treatment                               | Total Dosage       | Result and Final Vision | Relapses | Period of Observation After Treatment |
|------|---|---|--------------------|-------------------------|----------|---------------------------------------|
| 1    | Right eye, 20/100                       | 1 Gm. for 3 to 5 sec. at 3 wk. intervals        | 1 Gm. for 85 sec.  | Healed 20/40            | 2        | 3 yr.                                 |
|      | Left eye, 20/30                         | 1 Gm. for 3 to 5 sec. twice weekly              | 1 Gm. for 88 sec.  | Healed 20/15            | 3        | 10 mo.                                |
| 2    | 2/200                                   | 1 Gm. for 6 sec. weekly                         | 1 Gm. for 30 sec.  | Healed 20/30            | None     | 2 yr.                                 |
| 3    | Limited to perception of hand movements | 1 Gm. for 5 to 10 sec. monthly                  | 1 Gm. for 80 sec.  | Healed hand movements   | None     | 2 yr.                                 |
| 4    | 20/50—                                  | 1 Gm. for 5 sec. weekly                         | 1 Gm. for 40 sec.  | Healed 20/20            | None     | 2 yr.                                 |
| 5    | 20/50—1                                 | 1 Gm. for 8 to 12 sec.; multiple areas biweekly | 1 Gm. for 147 sec. | Healed 20/30            | 1        | 8 mo.                                 |
| 6    | 20/40                                   | 1 Gm. for 5 sec. twice weekly                   | 1 Gm. for 45 sec.  | Healed 20/20            | None     | 7 mo.                                 |
| 7    | 20/200                                  | 1 Gm. for 8 to 10 sec. biweekly                 | 1 Gm. for 36 sec.  | Healed 20/200           | None     | 5 mo.                                 |
| 8    | Right eye, 20/200                       | 1 Gm. for 8 sec. weekly (2 areas)               | 1 Gm. for 40 sec.  | Healed 20/40—2          | None     | 2 mo.                                 |
|      | Left eye, 6/200                         | 1 Gm. for 8 sec. weekly (2 areas)               | 1 Gm. for 40 sec.  | Healed 20/100           | None     | 2 mo.                                 |
| 9    | Limited to perception of hand movements | 1 Gm. for 8 sec. weekly (2 areas)               | 1 Gm. for 74 sec.  | Healed 20/40            | None     | 2 mo.                                 |
| 10   | 20/50                                   | 1 Gm. for 5 to 10 sec. weekly                   | 1 Gm. for 35 sec.  | Healed 20/40 ?          | None     | 1 mo.                                 |

temporary improvement after only one course of treatment but had a relapse on her return to her home in a distant state. The data on these 3 cases are summarized in table 2.

Two patients of this series had in addition to the active keratoiritis in one eye, corneal scars from a former keratitis in the second eye. Beta irradiations were given to the second eye, with the idea of clearing the corneal opacities. To this end 1 patient received four such courses of irradiation, while the second patient received one course. The results observed were both peculiar and interesting. The first patient had vision of 20/70—1 in the inactive eye when treatment was instituted, and it was known that vision had not been above this level for the

preceding five years. After the first course of irradiation vision cleared to 20/30, and this vision was maintained for about two months, when, without further inflammation or activity of any sort, it gradually decreased to 20/70. A second and third course of irradiation had the same effect, vision again clearing to 20/30, only to decrease after several months to 20/50. A fourth course again resulted in clearing to 20/30, and after six months it had decreased only slightly, 20/40 vision being present at the last examination. At the time of writing the second patient had been under observation only five months and had received only one course of beta irradiation. At the beginning of treatment vision was 20/200. After one course of treatment it increased to 20/70. Three months later, however, again without evidence of any activity or exacerbation, it decreased to 20/200, the original level. The data for these cases are summarized in table 3.

TABLE 2.—*Effect of Beta Irradiation in Cases of Deep Tuberculous Scleritis*

| Case | Vision at Initiation of Treatment                              | Mode of Treatment  | Total Dosage       | Result and Final Vision            | Relapses | Period of Observation After Treatment |
|------|--|--|--------------------|------------------------------------|----------|---------------------------------------|
| 1    | Limited to perception of hand movements (atrophic choroiditis) | 1 Gm. for 5 sec.; multiple areas weekly (3 treatments with gamma rays) | 1 Gm. for 307 sec. | Greatly improved; hand movements   | None     | 2 yr.                                 |
| 2    | 20/70  | 1 Gm. for 6 to 12 sec. (3 treatments with gamma rays)                  | 1 Gm. for 94 sec.  | Healed 20/20                       | None     | 7 mo.                                 |
| 3    | 20/30 +3   | 1 Gm. for 5 sec. twice weekly  | 1 Gm. for 21 sec.  | Temporary improvement only 20/30+3 | 1        | 2 yr. (no further treatment)          |

#### COMMENT

It is well recognized that tuberculous keratoiritis frequently runs a limited course and may quiet spontaneously. There is also a known tendency of the disease to relapse, and the remissions between attacks may be years in length. Each attack, however, usually results in more or less corneal scarring, and in any attack the disease may spread throughout the uvea and the eye be lost. In view, therefore, of this known tendency of the disease frequently to subside spontaneously, the question may well be raised if the apparent healing of these eyes under beta irradiation is causally related to the treatment given.

In answer to this very pertinent question, it may first be pointed out that in several of the 10 patients with keratoiritis the ocular disease had been of long standing and the course had been progressively downhill, and in several others the disease was of such violence that at the onset of treatment the condition of the eyes appeared precarious and the ultimate outcome uncertain. If the subsidence of inflammation observed

in these patients is a normal recovery from a frequently self-limited disease, it is indeed a remarkable coincidence that it should have occurred in 10 consecutive patients within two to three months after the initiation of a new form of therapy. Further, the recovery of vision in this series of patients is rather unusual. Eight of the 10 patients had marked improvement in vision, while the vision of 2 was unchanged, although all evidences of active inflammation disappeared. These 2 patients, however, both had a heavy central sclerosing keratitis from former attacks; and while marked clearing of the cornea occurred, nevertheless the central opacity remained so dense that improvement of vision was impossible. Similarly, these patients showed remarkably little residual corneal scarring, and several did not appear to have any scarring from the attack. In view, therefore, of the past history of the patients, the severity of the disease in the majority of them, the constant and uniform subsidence of inflammation after initiation of treatment, the

TABLE 3.—*Effect of Beta Irradiation on Corneal Maculas in Cases of Inactive Tuberculous Keratitis*

| Case | Vision at Initiation of Treatment | Mode of Treatment   | Immediate Effect | Vision 3 Months Later | Additional Courses of Treatment | Vision After Each Course | Final Vision |
|------|-----------------------------------|---|------------------|-----------------------|---------------------------------|--------------------------|--------------|
| 1    | 20/70—                            | 1 Gm. for 3 to 5 sec. at 1 to 3 wk. intervals; total, 1 Gm. for 20 sec. | 20/30            | 20/70                 | 3                               | 20/30                    | 20/40        |
| 2    | 20/200                            | 1 Gm. for 8 to 10 sec. biweekly; total, 1 Gm. for 36 sec.               | 20/70            | 20/200                | None                            | .....                    | .....        |

improvement in vision and the lack of residual scarring, it appears a justifiable assumption that the beta irradiation may be causally related to the subsidence of inflammation.

It is quite true that the results in the cases of deep tuberculous scleritis were not as spectacular as those in the cases of tuberculous keratoiritis, but the tuberculous infiltration in the former condition is probably deeper than in the latter, and the sclera is possibly less permeable to rays than is the cornea.

The possible influence of other collateral therapy must also be considered. All of these patients received the usual indicated local therapy—atropine, hot applications and other measures. The majority of them also received tuberculin as a desensitizing agent. In at least 5 of the 10 patients with keratoiritis and in the 3 with scleritis the active disease had been of long standing and certainly had not been especially influenced by the local treatment. It is, of course, manifestly absurd to assume any dramatic desensitizing effect from two to three months' administration of tuberculin. Two patients had paracentesis done, 1 with the additional injection of her own blood into the anterior chamber. These procedures definitely resulted in temporary improvement but did not

appear to influence the outcome permanently. In short, when these case histories are analyzed, it does not appear probable that the collateral treatment they received was responsible for the therapeutic results observed.

What is the *modus operandi* of beta irradiation, assuming that it has an actual therapeutic effect in tuberculosis of the anterior portion of the eye? This question cannot be answered definitely. It is, of course, possible that this form of irradiation has a bacteriostatic or abiototic effect on the organisms, but there is certainly no experimental evidence to confirm such a view. The experiments of Thompson, Pfeiffer and Galardo indicated that irradiation of the cornea resulted in a local mobilization of antibodies. Recent investigations in the Wilmer Ophthalmological Institute have indicated that the cells of the cornea are capable of the production of local immune bodies, and this capacity of antibody production is accelerated by beta irradiation. These observations, however, require further confirmation before they can be accepted. While no acceptable explanation for the apparent therapeutic action of beta rays can yet be given, it is possible, however, that their action is in some way related to the production or augmentation of a local immunity.

The final point to be considered is the permanency of this apparent therapeutic effect. Again no definite answer can be given to such a question. It appears probable that even after the full effect is obtained the direct beneficial action may be limited to a few months, depending on the reaction of the patient. Certainly in 2 cases, after apparent healing, relapses occurred within three months, and the time of observation in the majority of the other cases is too short to hazard any guess as to the permanency of the cure. It is possible that all the organisms in the cornea and iris may have been destroyed and that therefore the cure may be permanent. This, however, appears improbable. A more likely view is that through some obscure action, possibly a stimulation of local immunity, the active inflammation is controlled. If this is correct, then such control could not be expected to last beyond a few months. If in this period of remission the general and local immunity can be built up and local desensitization obtained, then a more or less permanent cure might be expected.

Such a view as this at once brings up the question of further courses of irradiation after the primary healing, to maintain the local immunity and thus prevent recurrences. Certainly such a procedure is harmless, and it is possible that periodic irradiations with beta rays may prevent recurrences in a patient with a known tendency to recurrent attacks. Indeed, for several patients in this series who have suffered from recurrent attacks of tuberculous keratitis over years, with steady loss of vision and increasing organic damage to the eye, exactly this procedure is being used. As far as is practical, repeated beta irradiations are given

at intervals of about three months. Thus far no recurrences have been observed, but it is too early to hazard any guess as to the ultimate outcome. The difficulty of properly regulating such treatment for patients with no active symptoms, many living at great distances, is also manifest.

It is fully realized that the number of cases here reported is small and that the period of observation is inadequate. Definite claims of specific therapeutic action from beta irradiation are not yet justified. However, it can be said that the results obtained in these cases have in the main been consistent and in some instances striking and dramatic. It is hoped that further extension of this study to clinical cases and animal experimentation may demonstrate that the apparent promise of this form of treatment may be borne out. If so, for one limited form of ocular tuberculosis, a disease for which the therapeutic armamentarium is woefully deficient, there will be at least one direct method of attack.

#### SUMMARY

The results of treatment with the beta rays of radium of 10 patients with tuberculous keratoiritis and of 3 with deep tuberculous scleritis are reported. All patients with tuberculous keratitis showed prompt subsidence of all inflammation after one course of treatment, although 2 had recurrences, again controlled by further irradiation. Deep scleritis was more resistant, steady treatment over a greater period of time being required before any decided improvement occurred. One patient with scleritis apparently recovered, 1 showed marked improvement and 1, probably inadequately treated, had a relapse after treatment was stopped. The possible causal relation of beta irradiation to the therapeutic results, the possible mode of action of such irradiation and the question of permanency of results are discussed.

blood pressure or other vital signs. She received a large quantity of fluids, consisting of about 1,500 cc. of 5 per cent dextrose in saline solution and 1,000 cc. of citrated blood.

The postoperative course was uneventful except for ecchymosis of the left eyelids, subconjunctival hemorrhages and transient diplopia, all of which cleared within one week. The patient was discharged from the hospital in good condi-

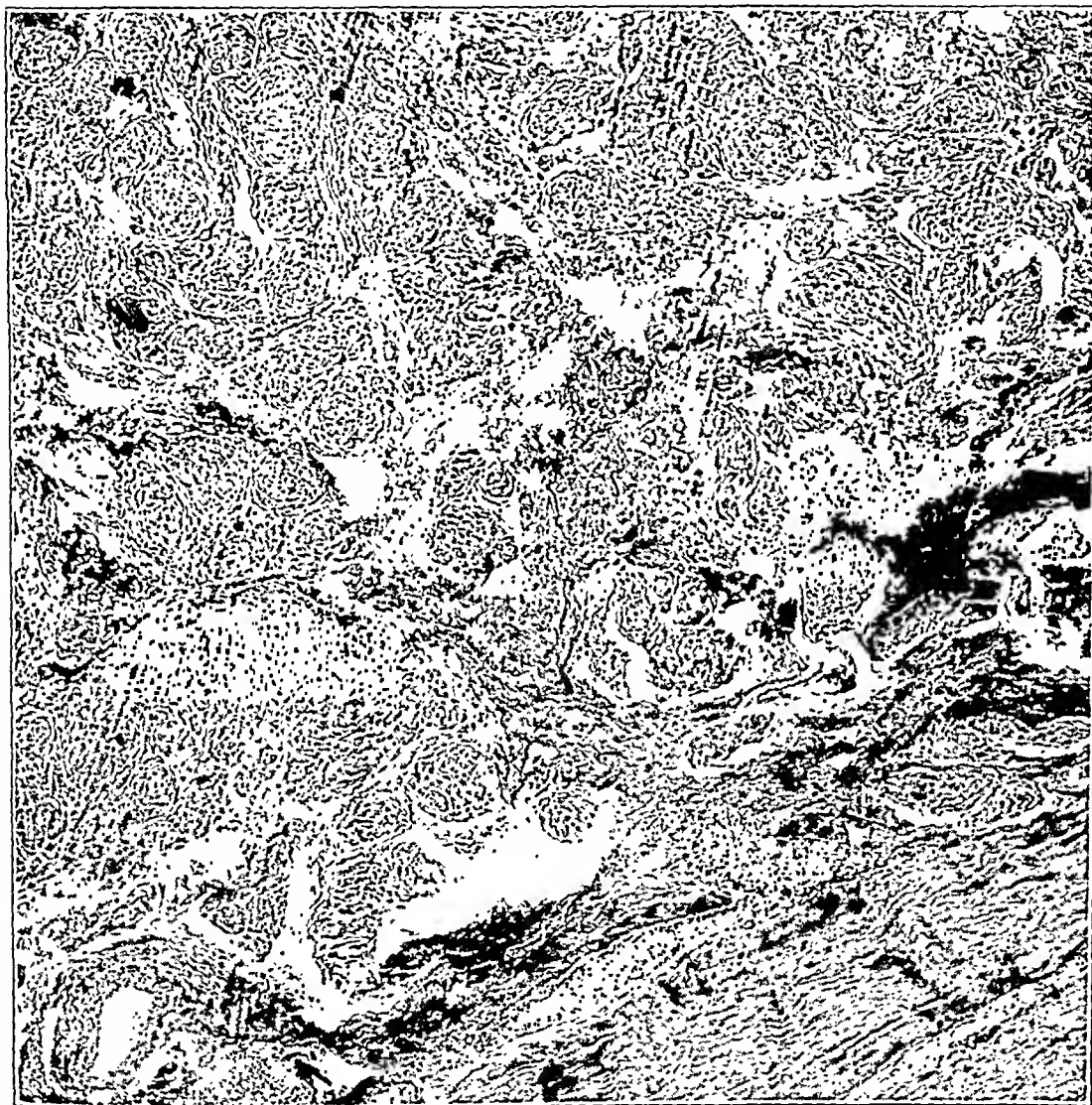


Fig. 4.—Section of meningioma, showing closely packed whorls arising from the congested dura;  $\times 65$ .

tion fourteen days after operation. The pathologic report by Dr. I. M. Tarlov follows:

The tumor was found on microscopic examination to be cellular with a broad attachment to the dura mater. The tumor was divided into lobules by connective tissue trabeculae which were continuous with the dura. The nuclei of the tumor cells were moderate in size, round or oval, rather rich in chromatin and surrounded by fair amounts of cytoplasm with indistinct borders. Most of the cells were round or cuboidal, few elongated forms occurring. Moderate numbers

# HYPERPHORIA TESTS BASED ON A NEW PRINCIPLE

F. H. VERHOEFF, M.D.

BOSTON

For the purposes of this communication it is necessary to define binocular fixation. So far as I know, this function has never been accurately defined. In fact, defining it is not generally recognized as constituting any problem. The following definitions seem adequate for the purposes at hand and will, I believe, prove of general usefulness. Binocular fixation of two punctate retinal images is the act of maintaining these images on corresponding retinal points by means of motor response to these images. Corresponding retinal points I have defined elsewhere.<sup>1</sup> Binocular fixation of two contours, one on each retina, is the act of maintaining at least two geometric points, one in each contour, on corresponding retinal points by means of motor response to these contours. Punctate retinal images or contours may by chance fall on corresponding retinal points. Hence to prove the existence of the required motor response to these images or contours it is necessary to demonstrate that the eyes are suitably readjusted when one of the images or contours is suitably displaced. Failure of this readjustment to occur is presumptive but not conclusive evidence that binocular fixation of the images or contours concerned did not exist.

Binocular central fixation exists when at least one of the two corresponding points concerned is foveal, and peripheral binocular fixation exists when neither of these points is foveal.

Normally when there is binocular central fixation, in the case of punctate retinal images both are foveal and in the case of contours one geometric point in each is foveal. This is shown by the fact that when either eye is occluded no movement perceptible subjectively to the patient or objectively to an observer occurs, and the clarity of the image appears maximal for the eye concerned. As I shall point out in another communication, there are certain cases in which, although there is binocular

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From the Howe Laboratory of Ophthalmology, Harvard University, and the Massachusetts Eye and Ear Infirmary.

Read at the Seventy-Fifth Annual Meeting of the American Ophthalmological Society, Hot Springs, Va., June 7, 1939.

1. Verhoeff, F. H.: Anomalous Projection and Other Visual Phenomena Associated with Strabismus, *Arch. Ophth.* **19**:663 (May) 1938.



central fixation, when one eye is occluded the other is compelled to move in order to make the image appear of maximal distinctness for this eye.

Binocular fixation of two retinal images larger than punctate images consists in the binocular fixation of some point in one image and some point in the other, or of a contour in one image and a contour in the other. In either case, the fixation is central when at least one of the two corresponding retinal points concerned is foveal.

Binocular fixation of an object in space is synonymous with binocular fixation of its retinal images.

It is to be noted that these definitions are valid no matter what view may be held as to the nature of the mechanism of binocular fixation. They apply when the retinal images concerned are dissimilar and even when the images arise from different objects, as, for instance, when a stereoscope is used. The unqualified term binocular fixation, as commonly used, refers to binocular central fixation and hereafter will be so used in this communication. Since the term ocular fixation is generally abbreviated to fixation, it seems legitimate to use bifixation for binocular fixation.

If one views a point on a large uniform frontal plane, binocular fixation of the point can be regarded as consisting of motor responses which adjust the eyes first horizontally and then vertically. One can therefore speak of binocular fixation consisting of two vertical and two horizontal components for each eye.<sup>2</sup> Whether these components correspond to real physiologic functions need not be considered here. Suppose a long vertical uniform line is substituted for the point on the background. Obviously, the only stimuli to the vertical components are the ends of the line, and since the line is long these are inadequate to produce binocular fixation. Strong stimuli to the horizontal components, however, exist, and binocular fixation of the line occurs. This may be termed horizontal binocular fixation. Similarly, a long uniform horizontal line can give rise to vertical, but never to horizontal, fixation. It is to be noted that binocular fixation of a line at an angle to the vertical could consist only of vertical components, only of horizontal components or of various combinations of both; whereas binocular fixation of a vertical line can consist only of horizontal, and that of a horizontal line, only of vertical, components.

It is well known from experimental evidence that except in highly unusual cases the range of deviation within which binocular fixation can occur is much greater for horizontal than for vertical fixation and that

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2. The terms vertical and horizontal, of course, are used in this paper with reference to the plane which passes through the point of fixation and the centers of ocular rotation.

for the same range horizontal fixation is achieved much more rapidly than vertical. For this reason it would be expected that ordinarily when a point is fixed binocularly the necessary ocular horizontal movement would occur first and then the vertical. Experiments with prisms show that this is actually true and that, in fact, the vertical fixation may remain not complete if there is relatively great vertical deviation to be overcome. Therefore, for this reason alone the differentiation of the components of binocular fixation into vertical and horizontal is not entirely arbitrary.

The term fusion is commonly employed as if synonymous with binocular fixation. But it is also commonly used to designate a purely sensory process. It is true that, contrary to general belief, fusion in the latter sense cannot occur when the images concerned do not occupy corresponding retinal areas,<sup>3</sup> but binocular fixation frequently occurs without fusion. For instance, if the images differ in intensity or color, the image consciously perceived may have the intensity or color of one image only. The term fusion as a designation for binocular fixation is superfluous, to say the least, and as a designation for the sensory process it conveys a false idea of what actually occurs, as I have elsewhere pointed out.<sup>3</sup>

Heterophoria is generally defined as a tendency for the eyes to deviate with respect to each other during binocular fixation. This concept seems to be based on the fact that in certain cases when binocular fixation is eliminated by occluding one eye or altering the visual stimulus in one eye, this eye takes a deviated position with respect to the other eye. The direction and amount of this deviation are regarded as corresponding to the direction and amount of heterophoria. The tests which elicit the deviation in question, however, measure not a condition or tendency that exists during binocular fixation but an actual deviation which occurs in its absence. Hence without further evidence it is a mere assumption that this deviation is a measure of heterophoria, no matter how reasonable the assumption may appear to be. I shall, therefore, term the deviation presumptive heterophoria.

Heterophoria is differentiated into vertical and horizontal components, that is to say, into hyperphoria and laterophoria, which may coexist, and into right and left hyperphoria, esophoria and exophoria. While so far as I know no reason has ever been given for this differentiation, for present purposes, as will be evident later, it is of essential importance because it accords with differentiation of binocular fixation into vertical and horizontal components. Presumptive heterophoria, of course, is to be differentiated in the same way. So-called cyclophoria belongs in a different category and will not be considered here. I have

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3. Verhoeff, F. H.: A New Theory of Binocular Vision, *Arch. Ophth.* **13**: 151 (Feb.) 1935.

discussed it elsewhere.<sup>4</sup> Since presumptive heterophoria may differ in degree and in kind when elicited by different methods and even when elicited by the same method under different conditions, the exactness of its meaning depends on the exactness with which these methods and conditions are described. Unless otherwise stated, it is generally assumed that errors of refraction have been corrected and that the eyes are in their primary positions before the test is made. Under these conditions, one can, for example, speak of presumptive esophoria of 3 prism diopters for distance, determined by the cover test or by the Maddox rod test, as the case may be.

All present evidence indicates that except possibly in cases of marked presumptive heterophoria the eyes are in complete equilibrium with respect to each other during binocular fixation, whether or not they deviate at other times. It can be said either that there is during binocular fixation no tendency for the eyes to deviate or that a tendency to deviation in any specified direction is balanced by a tendency in the opposite direction. Hence, heterophoria of a specified type may be defined as a condition in which during binocular fixation the eyes have a relatively constant abnormal tendency to deviate in a specified direction with respect to each other, which tendency is balanced by an abnormal tendency in the other direction. Since a tendency to deviate can be overcome physiologically only by innervation, heterophoria must necessitate the employment of innervation which differs in degree, in kind or in both respects from that normally employed during binocular fixation.

Since the eyes are in equilibrium, as just stated, during binocular fixation, there is at present no direct evidence that heterophoria actually exists. There is, however, indirect evidence available that in many cases it does exist. If a variable prism is placed before one eye of a person who continues to fix binocularly a distant point and the prism is gradually increased in power, discomfort will soon be experienced and the binocular visual acuity impaired. Since the change in innervation necessary to cause the deviation produces abnormal effects, it must be abnormal. However, it is abnormal only in degree, for the ability to overcome prismatic deviations in the interest of binocular fixation is a normal function. This simple experiment proves conclusively that when the change in the deviation of the eyes in the interests of binocular fixation is sufficiently great it produces discomfort and impairs visual acuity and that these effects result from the employment of an abnormal amount of a special but normal kind of innervation.

In many cases in which presumptive heterophoria has been demonstrated, a corresponding prismatic correction relieves discomfort and improves binocular visual acuity. This fact indicates that without the

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4. Verhoeff, F. H.: Cycloduction, *Tr. Am. Ophth. Soc.* 32:208, 1934.

correction there is being used innervation of the same kind as in the foregoing experiment, and likewise abnormal in degree, and therefore that heterophoria actually exists in these cases.

The foregoing considerations permit heterophoria of a specified type to be defined as a tendency for the eyes to deviate in a specified direction with respect to each other, which tendency, during binocular fixation, is overcome by the employment of an abnormal amount of a normal kind of innervation. The measure of the tendency is the prismatic deviation required to reduce this innervation to a normal amount.

In attempting to define heterophoria, Bielschowsky<sup>5</sup> employed the term "anomalous position of relative rest." But since the same difficulties remain in defining "relative rest" as in defining heterophoria itself, this term is deceptive in conveying the notion that it clarifies the concept of heterophoria.

A practical problem is that of devising a test for presumptive heterophoria which will indicate with sufficient accuracy the amount of actual heterophoria; that is to say, which will indicate the prismatic correction or its equivalent for the type or types of heterophoria existing that will give the optimum combination of comfort and visual acuity under the conditions for which they are most needed. The so-called heterophoria tests commonly employed are really tests for presumptive heterophoria, and each introduces factors of unknown importance that may lead to incorrect interpretations. The simple parallax test (cover test), subjective or objective, is probably the best, because presumably it removes from one eye at a time all the stimuli to binocular fixation. But when one eye is occluded, effects other than those due to the removal of these stimuli may occur, and the position the eye then assumes may therefore give an incorrect indication of tendency or lack of tendency to ocular deviation during binocular fixation. A person may experience a greater feeling of effort and discomfort from the occlusion of one eye than from the use of both eyes even when there is a considerable degree of presumptive heterophoria indicated by the cover test. It is known that in cases of so-called double hypertropia, when either eye is covered it deviates upward and when it is uncovered it comes down, in spite of absence of binocular fixation. It is true that this is supposed to be an abnormal reaction, but conceivably it may occur in some degree even in "normal cases," for abnormal conditions are often but exaggerated normal conditions. On the other hand, there are cases in which an eye does not deviate when covered in spite of the existence of considerable presumptive heterophoria. I have encountered more than one patient who showed "orthophoria" by the cover test until he was told to relax

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5. Bielschowsky, A.: Lectures on Motor Anomalies: Theory of Heterophoria, *Am. J. Ophth.* **21**:1129 (Oct.) 1938.

his eyes. Then the covered eye underwent marked divergence. Evidently such patients have somehow learned to employ at will the innervation needed to keep their eyes straight, even when one eye is occluded. When one eye is covered, an object may appear at a different distance, and hence there may be elicited a considerably different impulse to convergence than existed in binocular vision. For this reason, no doubt, the cover test is particularly unreliable for the reading distance. If the pause of the cover before each eye is brief, a stimulus to binocular fixation may result.

The Maddox rod test, as usually employed, is open to several serious objections. It does not completely abolish all stimuli to binocular fixation; there is some tendency to bifixate the streak and the light or the streak and some other object, such as a figure on a Maddox scale. When, as is usually the case, the rods consist of red glass, additional accommodation is required to make the streak appear clear. In some cases the streak may appear close to the patient and when fixated may then cause excessive convergence. Moreover, I have found that a bright source of light tends to stimulate convergence unduly and hence is less suitable as a test object than a black spot or letter on a white background, such as may be used in some other tests. For these and possibly other reasons, the Maddox rod test may indicate esophoria of 10 prism diopters or more when the cover test indicates slight exophoria. However, by a simple modification, seldom employed, the Maddox rod test may be made to yield results that closely approximate those given by the cover test. This modification consists in covering the eye before which the Maddox rod has been placed and ascertaining the apparent position of the streak at the instant the cover is removed.

Incidentally, a fact, not previously pointed out so far as I know, is that the Maddox rod furnishes a simple method for determining the existence of binocular fixation. While the patient is "looking at" a light, a Maddox rod is quickly dropped before one eye. If he sees a streak pass through the light, the two images of the light must have been on corresponding retinal points. If now a weak prism, say 1 prism diopter, is placed before one eye and the test is repeated with the same result, the patient obviously has the ability to fix the light binocularly.<sup>6</sup>

Objections similar to those mentioned apply also to the tests which depend on the production of diplopia by means of prisms. Tests for presumptive heterophoria made by the use of a stereoscope of any kind are especially unreliable, because the observer has no accurate idea of the distance concerned.

A method believed to measure hyperphoria is that of ascertaining the strongest prism, base down, that can be overcome and then the

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6. It is especially important in this test that the Maddox rod or disk of multiple rods is free from prismatic defect.

strongest prism, base up. One-half the difference in the strengths of the two prisms is considered to be the amount of hyperphoria. This difference could be accounted for by hyperphoria or by a real difference in the ability disjunctively to deviate the eyes vertically in one direction and in the opposite direction or by both. Since the test does not distinguish between these possibilities, it is not necessarily even an indirect test for hyperphoria. The fact that it is often in substantial agreement with the cover test suggests that usually the most important factor is the same in both tests. This factor, however, is not necessarily hyperphoria; it could reside in the sursumduction mechanism and be effective in the absence of hyperphoria.

For my present purposes it is not necessary to consider the various possible causes of heterophoria or to discuss at length the complex sensory and motor mechanisms that have to do with binocular fixation. In cases of heterophoria, deviation of the eyes with respect to each other is believed to be prevented by the duction mechanism. As regards hyperphoria, this belief is doubtless correct, because there is no other known function that could prevent vertical deviation. But for laterophoria it is not necessarily correct, because horizontal deviation could be prevented by the function known as voluntary convergence and also by oculomotor innervation produced by the sense of distance.<sup>7</sup> However, when there is binocular fixation there is probably even in "normal cases" always some residual horizontal deviation which is being overcome by lateroduction. In fact, it seems to me almost certain that the final determination of binocular fixation is wholly dependent on the duction mechanism; in other words, binocular fixation cannot be maintained with its normal precision without the aid of this mechanism. The evidence for this statement will be considered in a later communication.

There is conclusive evidence that sursumduction and cycloduction are entirely involuntary functions. Conceivably, by a conditioning process, voluntary control over sursumduction could be acquired, but so far as I know this has never been accomplished. No doubt lateroduction likewise is entirely involuntary, but the evidence for this is not so conclusive, since in experiments bearing on this question the possibility of voluntary convergence and other factors playing a part cannot be excluded with certainty. However, the fact that prisms, base in or out, or their equivalents can be overcome without change in accommodation and without corresponding change in idea of distance is strong presumptive evidence that lateroduction essentially similar to sursumduction, and therefore involuntary, occurs.

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7. For the same reason, the common assumption that the effect of a prism, base in or out, is always overcome by lateroduction alone is probably incorrect.

In the ocular muscles there are certain fibers that much more closely resemble smooth muscle than do the others.<sup>8</sup> It seems to me probable that duction is carried out by means of these fibers, for the relative slowness, limited range and persistence of duction are characteristic of smooth muscle. If this view is correct, these characteristics of duction are peripherally, not centrally, imposed. By exercise, the effectiveness of the involuntary muscle fibers could be increased. This may account for the fact that the range of duction can be greatly increased by prism exercise and for the fact that in some cases of presumptive hyperphoria the range of sursumduction may reach over 20 prism diopters, whereas normally it is less than 4 prism diopters. Although duction is an involuntary process, its exercise, as already indicated, may cause a feeling of effort which varies in degree with the amount of duction employed and which may cause severe discomfort. So far as I know, no explanation has been given of this fact. Possibly the sensations arise from the ocular muscles, owing to conflicting action of voluntary and involuntary muscle fibers. If so, the use of the term eyestrain in this connection would have some justification. As a matter of fact, the subject usually attributes the disturbance vaguely to his eyes. On the other hand, the possibility has not been excluded that the disturbance may be entirely central.

The differentiation of duction into sursumduction, adduction and abduction may be entirely arbitrary, but for practical purposes it is useful. Possibly instead one should speak of duction out at 45 degrees, etc. This question is complex and does not require discussion here.

Theoretically, it would seem possible, owing to irregularity in action of the ocular muscles, dependent wholly or in part on abnormalities in their attachments, that the innervation necessary for horizontal binocular fixation would affect the vertical deviation of the eyes and vice versa. Such an effect might be expected to be especially great when heterophoria was of high degree and also might be expected to cause hyperphoria for near vision to differ from that for distance.

From the foregoing considerations, it is evident that the tests usually employed for presumptive heterophoria cannot be relied on for the exact determination of actual heterophoria. It would seem that the amount of hyperphoria, that is to say, the real amount of sursumduction usually being employed, could be indirectly determined by presenting stimuli to horizontal fixation alone, and then, while horizontal fixation was being maintained, by ascertaining the vertical deviation remaining. At least it would seem that the presumptive hyperphoria measured in this way would be much more likely to correspond to the actual hyperphoria than the presumptive hyperphoria measured by the usual tests. So far as I

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8. Irvine, S. R.: Histology of the Extra-Ocular Muscles, *Arch. Ophth.* 15:847 (May) 1936.

know, this principle has never previously been considered. Recently I have devised several methods for applying it to the determination of hyperphoria. Thus far I have been unable to apply it to the determination of laterophoria, chiefly because the horizontal deviation which occurs when there are stimuli only to vertical binocular fixation is dependent largely on factors other than the absence of stimuli to lateroduction, which factors are variable and quantitatively undeterminable by present methods. Fortunately, adduction and even abduction have such wide ranges or are so greatly assisted by other factors that for practical purposes at least laterophoria does not usually require more exact determination than is possible by means of the cover test.

As already indicated, the purpose of excluding all stimuli to vertical binocular fixation while retaining adequate stimuli to horizontal binocular fixation can be accomplished by means of a target with vertical lines only and of such large size that it extends beyond the limits of the binocular visual field. Obviously, so large a target would be impractical for use at a distance of 6 meters. I have avoided this difficulty by employing a square target only 72 cm. in width and placing before one eye of the subject a tube (3.8 cm. long) at the distal end of which is a diaphragm. By means of the diaphragm, preferably an iris diaphragm, the field of this eye is restricted to the central half of the target. A larger target would be advantageous if sufficient space was available for it. In this way all stimuli to sursumduction are removed except those furnished by the margins of the diaphragm and the upper and lower margins of the target. Owing to the wide separation of these margins, to the fact that the margin of the diaphragm is a circle whereas the edges of the target are straight lines and to the fact that the margin of the diaphragm appears greatly blurred, these stimuli are negligible, as I have found to be the case by actual tests. The most satisfactory target that I have employed consists of a black cardboard with a median vertical white line 12 mm. wide and 72 cm. long. Multiple vertical lines are unsatisfactory, because they may cause incorrect fixation; for instance, two lines may be combined into three lines. As indicators, two small holes are placed in the middle of the target, horizontally with respect to each other. Each is 4.5 mm. in diameter and separated from the white line by a distance of about 7 cm. They are illuminated from behind in such a way that the one on the right is seen by the right eye only and the other by the left eye only. This can be accomplished in several ways, the most practical of which for the distance test I have found to be the use of polaroid screens.<sup>9</sup> For the holes, polaroid film is satisfactory. Before the eyes, polaroid glass such as is used in

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9. I have found the use of colored screens for this purpose to be unsatisfactory, if only because they cause artificial anisometropia. A red glass before one eye and a green glass before the other causes anisometropia of about 1 diopter. To correct this with lenses introduces possible inaccuracies in the test.



spectacles is preferable; polaroid film is likely to become distorted and scratched. It is, of course, a simple matter to adjust the polaroid glass and film and the intensity of the light so that one hole is seen by one eye only and the other hole by the other eye only. It is essential to arrange the illumination of the target so that reflections from the surfaces of the film in the holes are not visible and to keep the target free from spots that might cause sursumduction.

Behind each hole is placed the polaroid film, and behind this a sheet of white translucent celluloid to diffuse the light. As a source of illumi-

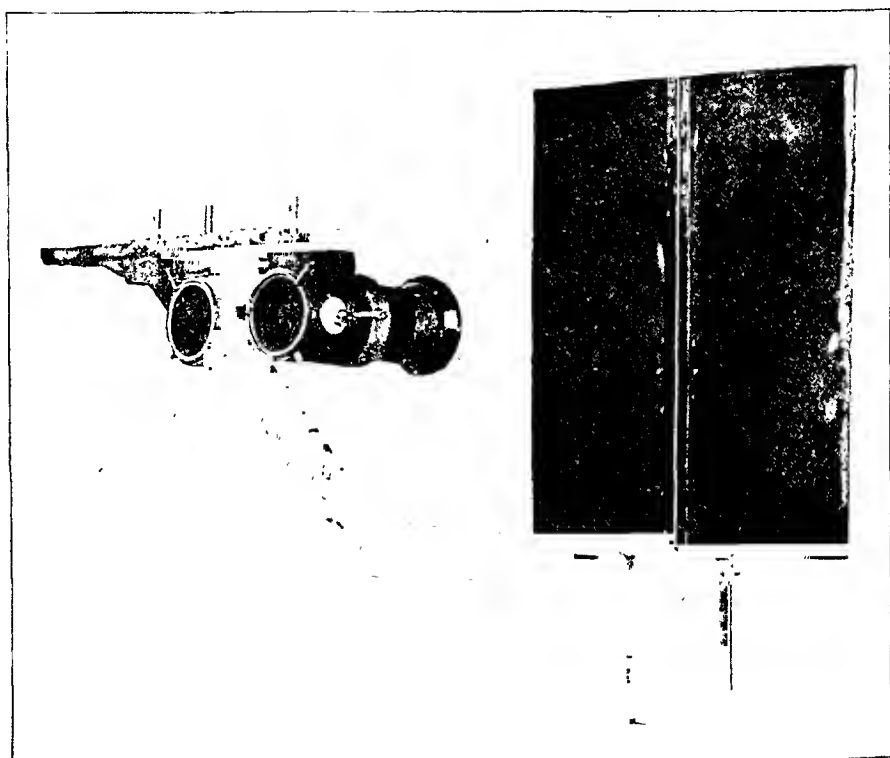


Fig. 1.—Apparatus for the vertical line test of presumptive hyperphoria, showing the target in place of the near test. For the distance test, this target is removed and a similar target of suitable size is placed at a distance of 6 meters. The apparatus may be held in the left hand of the patient or supported by a suitable stand. The attachment which holds the near target may be easily removed if desired. Reflections from the surface of the target, although apparent in the photograph, are easily avoided while making this test.

nation of the holes, I have found suitable a single 15 watt Mazda electric bulb fastened 8 cm. behind the target. The light is directed into the holes by white paper reflectors.

The selection of the distance between the two holes was based on the considerations that if the distance is too slight the holes are easily

bifixated; if it is too great the estimation of their apparent horizontality with respect to each other is too difficult, and, in addition, the effect of torsional deviation might become evident.

To measure the amount of presumptive hyperphoria, I employ a Hughes variable prism which produces a maximum deviation of 15 prism diopters. This is mounted in the proximal end of the long tube and is manipulated by the subject. A variable prism with a maximum deviation of 4 or 6 prism diopters would give readings more delicate than required in view of the fluctuations in deviation and would have the disadvantage of making the apparent movements of the hole less rapid. Within this tube is, of course, also placed one of the polaroid glass screens, so mounted that it can easily be removed when desired. Before the other eye is another tube, which, however, is only 1.6 cm. in length and contains the other polaroid screen. The two tubes are attached to a horizontal bar, which may be held in the patient's hand or supported by a suitable stand.

To make the test, the patient is seated 6 meters from the target and is instructed to look at it through the two tubes. The iris diaphragm, at first fully open, is reduced in diameter until the patient can see through it only about half the target; it is important, of course, for him not to see through it either the upper or the lower margin of the target. He then adjusts the prism until the two holes appear to be horizontally in line. If, as rarely happens, the two holes are bifixated so that he sees three holes or only one hole, this effect can be dissipated by rotating the prism until the lights appear to separate vertically. By rotating the prism rapidly, a satisfactory reading may be obtained. The observation should be continued so long as there is any measurable increase in the hyperphoria.

In some cases in which there is marked presumptive laterophoria, binocular fixation of the vertical line is easily lost, owing to the small field presented to one eye when the target is at 6 meters. This difficulty can usually be overcome by placing the patient at a distance of only 3 meters from the target. There is a possibility that even in the absence of definite paresis the presumptive hyperphoria may differ according to which eye is fixating. This could be ascertained with sufficient accuracy by instructing the patient to "look" steadily for a time first at one hole and then at the other. Theoretically, it would be better for the patient to maintain fixation on one hole while the polaroid screens behind the holes were alternated. It would seem that either of these methods would give more reliable results than Marlow's method of prolonged alternate occlusion of the eyes.

Instead of using two holes as indicators, the principle of the cover test may be employed. This may be done by having only one hole in the cardboard and moving, preferably by means of a motor, two suitably

adjusted polaroid screens behind the hole, so that it is visible to only one eye at a time. The hole is placed close beside the vertical line. When there is presumptive hyperphoria, the hole appears to jump up and down, just as in the usual cover test, and the amount of deviation is ascertained by rotating a variable prism until the apparent movement ceases. This method, although having certain special advantages, lacks the simplicity of the previous one, and I therefore do not recommend it for general use.

For the near test (at 33 cm.) a much larger field can be conveniently employed, and polaroid screens are not used. The width of the target is 18 cm. and that of the white vertical line 0.75 mm.; the holes are each 0.75 mm. in diameter and are separated 2.5 cm. Behind the holes is a short tube so partitioned that a light from behind illuminates the right hole for the left eye only and the left hole for the right eye only. The light is diffused by a sheet of translucent celluloid. The target is held by an adjustable and removable attachment and may be conveniently illuminated from in front by daylight and from behind by artificial light or vice versa.

Another test that I have employed utilizes in addition to the new principle already explained another new principle, namely, the use of stereopsis as an indicator of presumptive hyperphoria. The target consists of a white cardboard bearing two black vertical lines, between which is placed vertically the arc of a circle. For the distance test the cardboard is 72 cm. high and 58 cm. wide. The arc has a length of 55 cm. and a radius of 57 cm. The width of line forming the arc is 6 mm. and that of the vertical lines about the same. The vertical lines are separated 10.5 cm. These dimensions are those I first arbitrarily selected, and I have since been unable to improve on them. For the near test the dimensions are relatively the same but reduced to correspond to the distance of 33 cm. A tube is used to restrict the field of one eye as in the previous test. When one retinal image of the arc is displaced vertically with reference to the other retinal image, horizontal fixation of the arc being maintained, horizontal disparateness is produced at both the upper and the lower portion of the arc but is opposite in kind, while no change in disparateness occurs with respect to the vertical lines. As a result the arc appears to tilt one end forward and the other end backward.

To measure the presumptive hyperphoria it is simply necessary to rotate the variable prism until the arc appears to lie in the reference plane, the plane of the two vertical lines. A change of less than 0.1 prism diopter is readily detected. This test requires good stereoscopic perception and the acceptance of artificially produced stereoscopic criteria. Usually a little practice is required before the stereoscopic effect is fully perceived. There is some stimulus to sursumduction, but usually this

is ineffective, so that the results correspond to those of the previous test. However, in some cases this test indicates less hyperphoria. No doubt this means that in such cases hyperphoria is easily overcome and that therefore a weaker prism than is indicated by the previous test may be prescribed. Whether or not this advantage is sufficient to warrant the routine use of the arc test remains to be determined.

It is interesting to note that to most observers when the arc appears tilted the parts seen outside the diaphragm, that is, by one eye only, also appear tilted just as they would appear if seen with both eyes.

By means of either of the tests described, it is, of course, easily possible, by turning the head in various directions, to measure noncon-



Fig. 2.—Target for the arc test of presumptive hyperphoria. This target may also be used for the determination of stereopsis and vertical aniseikonia. The actual dimensions are given in the text.

comitant, presumptive hyperphoria (so-called anisophoria).<sup>10</sup> In cases of marked presumptive laterophoria, owing to the horizontal deviations of the eyes, it is difficult accurately to measure vertical deviation by means of the usual tests. The new tests are free from this disadvantage, since they prevent horizontal deviation.

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10. It is known that, as concerns ocular motor relations, turning the head is not necessarily equivalent to turning the eyes. In the distance test it would be impractical to keep the head stationary and move the target. In the near test this could be done if desired.

The question arises as to the length of time necessary for the full amount or a large proportion of the presumptive hyperphoria to manifest itself in these tests. When experimentally a stimulus to sursumduction is removed without substitution of a different stimulus, a considerable interval must elapse before the original status is completely restored. The greater the amount of sursumduction and the longer it is maintained, the more slowly does restitution occur. As a rule, however, the restitution is practically complete within one minute. It is reasonable to assume that the same laws apply in the case of sursumduction used to overcome hyperphoria. However, so far as I know, there is no evidence as to how long duction which has been experimentally produced by stimuli acting for a long period of time, even a few hours, will persist after the stimuli have simply been removed.

If after producing sursumduction the stimulus is removed and the normal stimuli to binocular fixation are substituted for it, the sursumduction rapidly disappears. This suggests that the actual tendency to deviation under ordinary conditions could be more quickly determined in the following way: Suppose that by the vertical line test right hyperphoria of 3 prism diopters is indicated. With the prism set at 4 prism diopters of right hyperphoria, present to both eyes the same horizontal line or simply permit the patient to view for a few moments any ordinary distant objects. Then, with the stimuli for vertical fixation removed and with the prism still at 4 prism diopters, repeat the original test. If the presumptive hyperphoria now becomes less than 4 prism diopters, this would indicate that the real hyperphoria is less than 4 prism diopters; if it remains 4 prism diopters or becomes greater, this would indicate that the real hyperphoria is 4 prism diopters or more.

Marlow<sup>11</sup> assumed that occlusion of an eye for a week is necessary to elicit all the presumptive heterophoria. But this raises the question as to whether occlusion of the eye for so long a time does not introduce such abnormal conditions as to lead to the development of abnormal oculomotor relations. If an eye is completely excluded from vision, in the case of adults at least, it usually deviates markedly outward within a year. The deviation may reach 20 prism diopters or more in this time. Not infrequently this occurs in cases of cataract in which only one eye has been operated on. When after a year or more the other eye is operated on, there may at first be diplopia due to divergent strabismus. As a rule this soon disappears, but in some cases tenotomy of an external rectus muscle is required to relieve it. Obviously, from this fact it cannot be concluded that tenotomy would have been advantageous if there had

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11. Marlow, F. W.: A Tentative Interpretation of the Findings of the Prolonged Occlusion Test on an Evolutionary Basis, *Arch. Ophth.* **19**:194 (Feb.) 1938.

been no cataracts. Similarly, it cannot be concluded that the presumptive heterophoria manifested when one eye or first one and then the other eye has been occluded for a week necessarily indicates the correction that should be given when the eyes are under their usual conditions.

Marlow employed the Maddox rod test for the determination of presumptive hyperphoria after occlusion. It would probably increase the possible value of his method if the vertical line test were also employed.

It is to be noted that Marlow has attempted to determine the actual hyperphoria through the determination of the presumptive hyperphoria associated not only with complete absence of binocular fixation but with other abnormal conditions, whereas I have attempted to determine the actual hyperphoria through the determination of the presumptive hyperphoria which exists during horizontal binocular fixation under comparatively normal conditions.

As regards the correction of the presumptive hyperphoria indicated by the new tests, some of the problems confronted may perhaps be clarified by the following experiment. During the vertical line test while the presumptive hyperphoria is corrected by the prism, a horizontal line is quickly so placed that its retinal image passes through the fovea of one eye. The eyes are now in the positions necessary for binocular fixation of the crossing point of the two lines. But for binocular fixation of this point the horizontal line must give rise to a motor response. This motor response involves a change in innervation (and, according to my views, calls into action certain ocular involuntary muscle fibers). The question therefore arises as to whether this change in innervation does not of itself produce a deviation which must be overcome. If so, it is evident that correction of the presumptive hyperphoria either would not exactly correct or would overcorrect the actual hyperphoria. At present, the question here raised can be answered only by ascertaining the clinical results obtained by various corrections, a method obviously unsatisfactory. It can be satisfactorily answered only when a test is devised which will directly determine actual heterophoria. Possibly analysis of the ocular tremors which occur during binocular fixation would provide such a test.

Another question that arises is whether binocular fixation cannot be more precisely maintained in the presence than in the absence of a certain amount of actual heterophoria. If so, slight exophoria, which the cover test for presumptive heterophoria indicates is a normal condition, may be advantageous. Certainly, adjustment of voluntary muscles is more precise when they must overcome a certain amount of resistance. This question also can be answered satisfactorily when a direct test for actual heterophoria is devised.

At present, the best procedure to be followed in cases in which operation is not to be considered or has already been performed seem

to be as follows: With the refraction corrected, ascertain the presumptive heterophoria by the cover test and then by the vertical line test, first with the presumptive laterophoria uncorrected and then with it corrected. On the basis of these data and of the symptoms, decide on the amount of laterophoria to be corrected. With this correction made, again determine the amount of presumptive hyperphoria by the vertical line test and prescribe the full amount. Then reexamine the patient at intervals and modify the corrections as indicated by the same tests and by the symptoms complained of.

Incidentally, the arc test provides an excellent test for stereopsis and for this purpose could probably be standardized to yield quantitative results as to the delicacy of this function. It would then simply be necessary to ascertain the least change in prismatic deviation required to produce apparent tilting of the arc. Incidentally, also, this target provides a means of detecting artificially produced vertical aniseikonia. This does not mean that the test would necessarily detect aniseikonia that was not artificially produced, because the effects expected from aniseikonia may be overcome by experience. When this occurs, the aniseikonia may be said to be compensated. If the target is observed while a meridional size lens with its axis horizontal is before one eye, the ends of the arc appear displaced, both forward or both backward, with reference to the plane of the vertical lines. This is due to the fact that horizontal disparateness of the same kind is produced at the upper and lower parts of the arc. If the observer rejects stereoscopic criteria, the effect may not be apparent. If when the size lens is removed the arc still remains in a curved surface, noncompensated vertical aniseikonia will be indicated, and its amount can be determined by ascertaining the power of the image size lens necessary to dissipate the effect. For this purpose I have constructed a meridional size lens combination of variable power. This I have also used in conjunction with a different target in attempts to determine noncompensated horizontal aniseikonia.

Up to the present I have been more concerned with perfecting the tests described through observations made on selected subjects than with the testing of a large number of unselected patients. The results I have obtained show that the vertical line test for hyperphoria is of considerable practical value. For instance, in 1 case, although the usual tests showed 3.5 prism diopters of presumptive hyperphoria, this test showed only 1 prism diopter, and the subject, an ophthalmologist, was unable to wear a prismatic correction of 3 prism diopters. In 2 unusual cases in which the cover test showed hyperphoria of about 10 prism diopters and only slight laterophoria, the new tests showed in 1 case 3 prism diopters and in the other only 1.5 prism diopters of hyperphoria. In the latter case a prismatic correction of 3 prism diopters

produced diplopia of objects at 6 meters. However, just how great the practical value of the new tests may be remains to be determined by the results obtained in a large series of unselected cases. At present, only by clinical experience can it be determined whether or not factors that do not exist under the conditions of the tests make the actual hyperphoria differ to an important extent from the presumptive heterophoria. Perhaps the new tests will be found of practical value chiefly in cases in which there is a considerable amount of laterophoria.

#### SUMMARY

Attempts are made precisely to define binocular fixation and heterophoria. Tests commonly assumed to measure heterophoria do not necessarily measure tendencies for the eyes to deviate with respect to each other during binocular fixation but measure the actual deviation which exists during the absence of binocular fixation. It is suggested that this deviation be termed presumptive heterophoria. A distinction is drawn between horizontal and vertical binocular fixation. It would seem that the presumptive hyperphoria, if determined by presenting stimuli to horizontal binocular fixation while excluding stimuli to vertical binocular fixation, will closely correspond to the real hyperphoria. Simple methods for accomplishing this determination are described. One of the targets employed incidentally provides a means of measuring stereopsis and also a possible means of determining noncompensated vertical aniseikonia.

#### DISCUSSION

DR. JONAS FRIEDENWALD, Baltimore: I should like to call attention to two points which have a bearing on Dr. Verhoeff's contribution. In the first place, if an object, binocularly seen, is introduced above or below the disparate images, the instrument described by Dr. Verhoeff would be converted into an eikonometer. A number of months ago I set up such an apparatus. Artificial aniseikonia produced by placing a telescopic lens before one eye of an observer can readily be detected by this apparatus. I must confess that so far I have been unable to discover a clinical case of aniseikonia by the use of this procedure.

The second point I want to call attention to is that by introducing horizontal prisms of varying power in connection with the tests for vertical phoria one can discover the variation in the vertical separation of the images which corresponds to variations in convergence and divergence. It has interested me greatly to find that the hyperphoria varies greatly with different degrees of horizontal separation of the visual axes. In fact, I have found cases in which the vertical deviation was in one direction, say right hyperphoria, when the horizontal deviation of the eyes was suppressed and in the opposite direction, that is, left hyperphoria, when the horizontal phoria was allowed to become manifest. In such cases the failure to control the horizontal position of the eyes may lead to a totally erroneous estimate of the vertical phoria.



DR. F. H. VERHOEFF, Boston: I take it that Dr. Friedenwald has been working along the same lines that I have, but fortunately for me I have beaten him to publication. Many months ago I tried to measure vertical aniseikonia by the method of Dr. Friedenwald has described, but I found that peripheral binocular fixation of horizontal contours was not sufficiently precise to yield reliable results. The fact that presumptive hyperphoria as determined by my method may vary with the amount of lateriphoria corrected is brought out in my paper. In practice, the correction decided on for the horizontal deviation is placed before the eyes and then the presumptive hyperphoria determined.

Of course it is perfectly true, that one can use lateral prisms. One can correct exophoria or not, just as one likes. That point is brought out in the paper. One decides on what lateral prism one is going to give with a lateral correction and then finds out how much presumptive hyperphoria is left. The eyes are in complete equilibrium, and one does not know that there is any heterophoria. The only proof one has of it is purely clinical. When presumptive heterophoria is found, one puts on a prism and gets relief and also benefits the visual acuity; that is the only real test there is for the phorias. The other evidence is all presumptive. If a vertical prism is rotated vertically, after a while there is a feeling of discomfort and the visual acuity will be impaired. If a prism is given a patient with presumptive heterophoria and the visual acuity gets a little better and the discomfort is relieved, one feels that the condition really was hyperphoria. Is it not possible that a test might be devised which would show a real tendency to hyperphoria? It might be indicated by an analysis of the tremors which take place in binocular fixation, but at the present there is no perfect way of measuring them. I think that this still leaves lateral fixation twice as good as the ordinary test.

# PLEXIFORM NEUROFIBROMATOSIS (RECKLINGHAUSEN'S DISEASE) OF ORBIT AND GLOBE

WITH ASSOCIATED GLIOMA OF THE OPTIC NERVE AND BRAIN  
REPORT OF A CASE

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Plexiform neurofibromatosis of the eyelid and the region about the orbit and temple is a well recognized though rare manifestation of Recklinghausen's disease, usually appearing in early childhood. Other peripheral changes, such as cutaneous coffee-colored spots, molluscum fibrosum and multiple tumors of the peripheral nerves, are frequently present.

The disease is recognized by the presence of a thickened, pendulous upper lid, which is often accompanied by a tumor-like mass in the temple, orbit and side of the face. These masses are soft and when palpated have the feel of knotted cords. When the nerves of the orbit are involved there is usually some degree of proptosis and at times pulsation of the globe. Intraocular involvement also occurs, though it is rare.

I have been unable to find a record of a case of plexiform neurofibromatosis of the orbit and globe in which there was an associated tumor of the optic nerve, though diffuse overgrowth of the fibrous elements of the nerve, sometimes referred to as fibromatosis, has been recorded.

I have observed 2 cases of this disease, the first of which is the subject of this report. In this case there was also a glioma of the optic

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From the Department of Ophthalmology, University of Wisconsin Medical School.

Read at the Seventy-Fifth Annual Meeting of the American Ophthalmological Society, Hot Springs, Va., June 6, 1939.

This paper presents one aspect of a case previously reported before the Section on Ophthalmology at the Ninetieth Annual Session of the American Medical Association, St. Louis, May 18, 1939. The reader is referred to the latter paper (Primary Tumors of the Optic Nerve: A Phenomenon of Recklinghausen's Disease; a Clinical and Pathologic Study with a Report of Five Cases and a Review of the Literature, Tr. Sect. Ophth., A. M. A., to be published) for a more extended discussion of this subject.

nerve, with involvement of the brain, and cutaneous café au lait pigmented spots. Plexiform neurofibromatosis of the nerves of the orbit and globe were found on microscopic study of the tissues removed at autopsy.

The second case (fig. 1) was a more typical example of the disease. The lesion was confined to the upper lid and the region about the orbit and temple, the globe apparently being unaffected.<sup>1</sup> Typical pigmented patches in the skin were likewise present.

Three years ago the late distinguished ophthalmologist Dr. John M. Wheeler<sup>2</sup> presented an excellent paper before the American Ophthal-



Fig. 1 (case 2).—On the left, patient with plexiform neurofibromatosis of the left upper lid. On the right, the same patient, showing café au lait spots on the body.

mological Society concerning this subject, with the report of a case in which there was intraocular involvement. He reviewed the literature and referred especially to the case reports of six other members of the society, commenting that in none of the previously reported cases had involvement of the eyeball been present.

1. Dr. Ralph Stevens, a former house officer, referred this patient to me. Sections from a biopsy specimen of one of the tumor masses he removed from the region of the temple revealed a typical plexiform neurofibromatosis of the nerves (fig. 2).

2. Wheeler, J. M.: *Tr. Am. Ophth. Soc.* 34:151, 1936.

In view of the rarity of intraocular involvement and because of the presence of certain other unusual features, a detailed report of the first of my cases may be of interest.

#### REPORT OF CASE <sup>3</sup>

*History.*—B. C. (fig. 3), a girl of 3 years, was referred to the ophthalmic clinic of the Wisconsin General Hospital on Nov. 6, 1933, by the department of

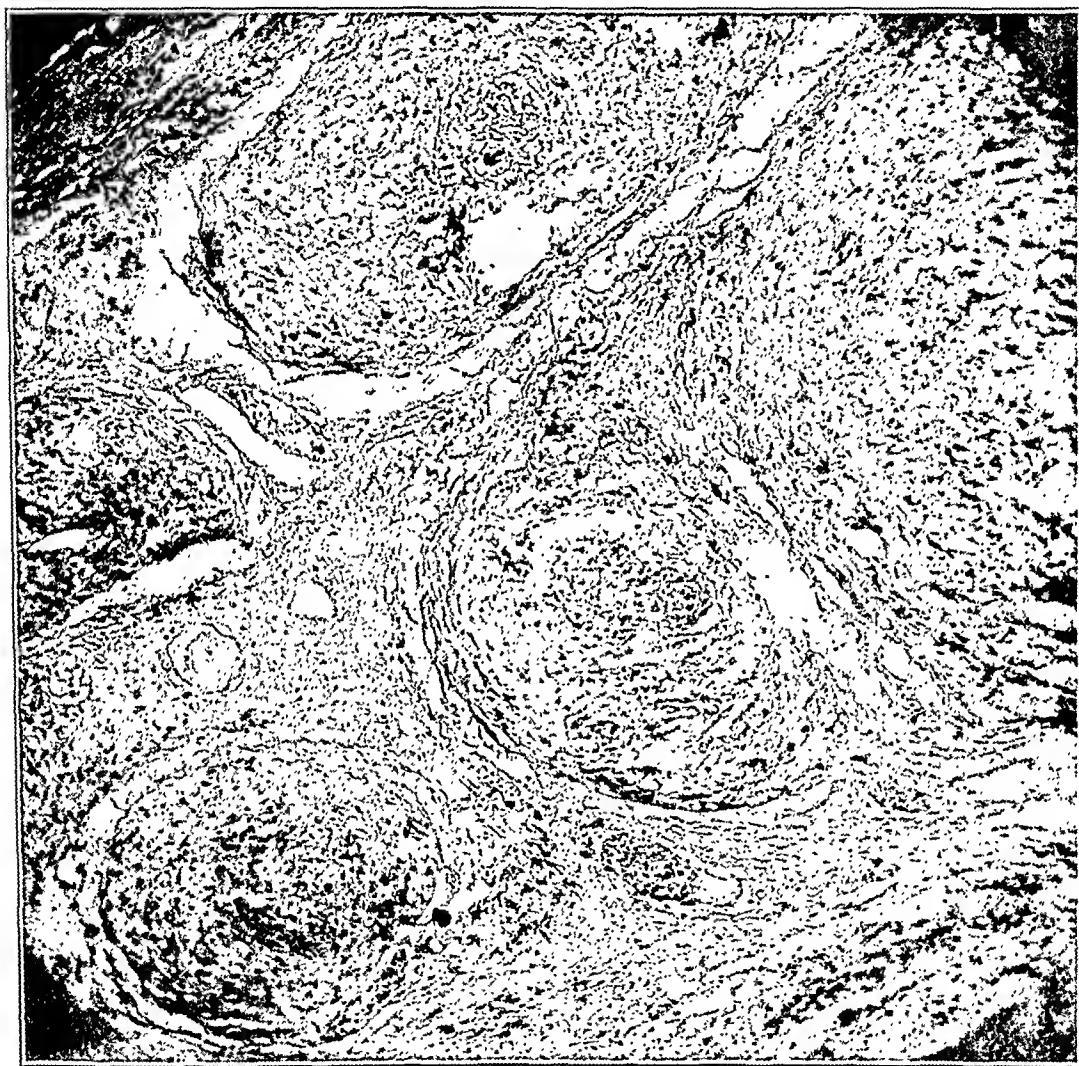


Fig. 2 (case 2).—Plexiform degeneration of the peripheral nerves. The section was taken from a biopsy specimen removed from a tumor mass on the left side of the face.

pediatrics, because of a slight protrusion of her right eye. She was born in the obstetric wards of the hospital, but nothing abnormal was noted at the time

3. A more complete history of this case has been given in my paper, "Primary Tumors of the Optic Nerve: A Phenomenon of Recklinghausen's Disease; a Clinical and Pathologic Study with a Report of Five Cases and a Review of the Literature" (Tr. Sect. Ophth., A. M. A., 1939, to be published).



Fig. 3 (case 1).—Appearance of the patient. There is slight exophthalmos of the right eye with convergence.

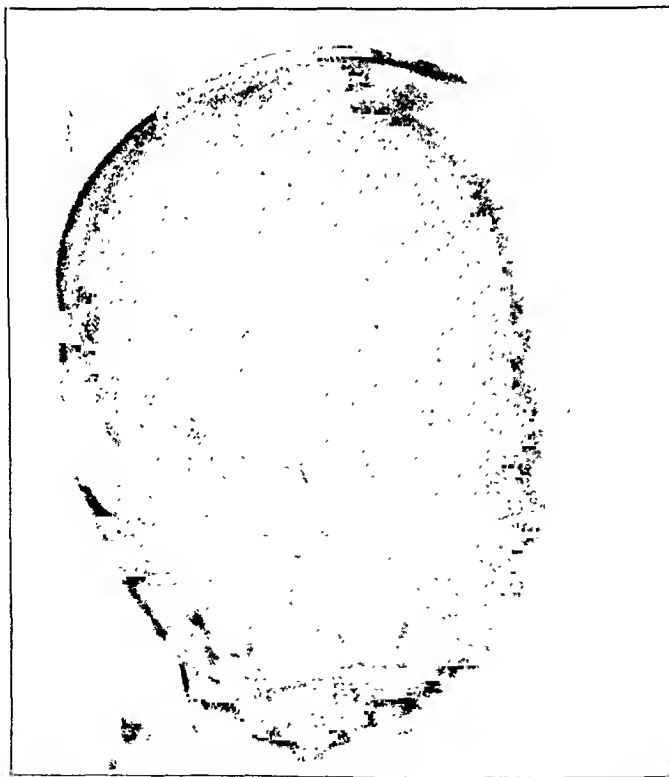


Fig. 4.—Anteroposterior view of the skull showing an increase in the size of the right orbit.

of birth. She was brought to the hospital at this time because of a slight burn on her leg which had not healed promptly.

*Examinations and Course.*—Examination of the eyes revealed slight exophthalmos of the right eye, which measured about 4 mm. There were slight ptosis and some limitation of motion of the globe in the field of the superior, inferior and external rectus muscles. A convergence of about 5 degrees was also noted. The globe appeared normal. The cornea was clear and the anterior chamber of normal depth. The pupil was larger than that of the left eye. It was somewhat irregular in shape, being drawn slightly to the temporal side. It reacted



Fig. 5.—On the left, café au lait spots on the back; on the right, café au lait spots on the left leg.

normally to light and in accommodation and dilated well with homatropine. Ophthalmoscopic examination revealed a normal lens and vitreous. The temporal half of the nerve head was pale. The margins of the disk were sharply defined. There was a large deep cupping in the temporal half of the disk, which was considered physiologic though it was regarded with suspicion. The fundus otherwise appeared normal. The eye was myopic, a  $-2.00$  D. sphere being required for a clear view of the fundus. Tactile tension was normal. The vision was markedly reduced.

The left eye appeared normal. The disk was round, the borders were sharply defined and the color was fairly good. A small physiologic cupping was noted. The eye was emmetropic, and the vision appeared to be unaffected.

The child was admitted to the wards, where she remained four days for a more complete study. Nothing further of significance was found. A tentative diagnosis of tumor of the optic nerve was made, and the mother was requested to bring the child to the clinic for periodic examination. Three months later the patient was again admitted to the wards. At this time it was thought that the exophthalmos had increased slightly. The pupil was drawn more to the temporal side, and the iris showed evidence of atrophy. There was some increase in pallor of the disk, which involved the nasal as well as the temporal half. The



Fig. 6.—Appearance of the patient at the age of 7, shortly before her death. Note the slight enlargement of the right cornea and the coloboma of the iris. Slight exophthalmos (3 mm.) was present. Note the excellent position of the globe and the faint line of scar following exploration of the orbit. There is paresis of the left facial nerve.

nerve head of the left eye was also considered to be slightly pale. The retinal vessels of both eyes appeared normal. Visual acuity again seemed to be much reduced in the right eye. Another routine physical examination revealed no abnormalities. The child had enlarged tonsils. A Wassermann test was negative. A roentgenogram of the skull on this occasion was reported to be "within normal limits," but a later reading of the films showed the presence of a definite asymmetry of the bony orbits, the right being larger than the left (fig. 4).

A subsequent examination of the child's body revealed the presence of a number of light coffee-colored patches in the skin, scattered over the trunk and extremities (fig. 5). There were one large patch on the back of the neck on the left side, several smaller spots on the back and two large round ones on the left thigh. These spots were nonelevated and smooth and did not blanch on pressure. They were pale. The mother stated that they were present at birth, though they were not noted on physical examinations, which had been made by three different physicians. (An examination of the mother also revealed similar pigmented spots in the skin, scattered over various parts of the body. Several soft

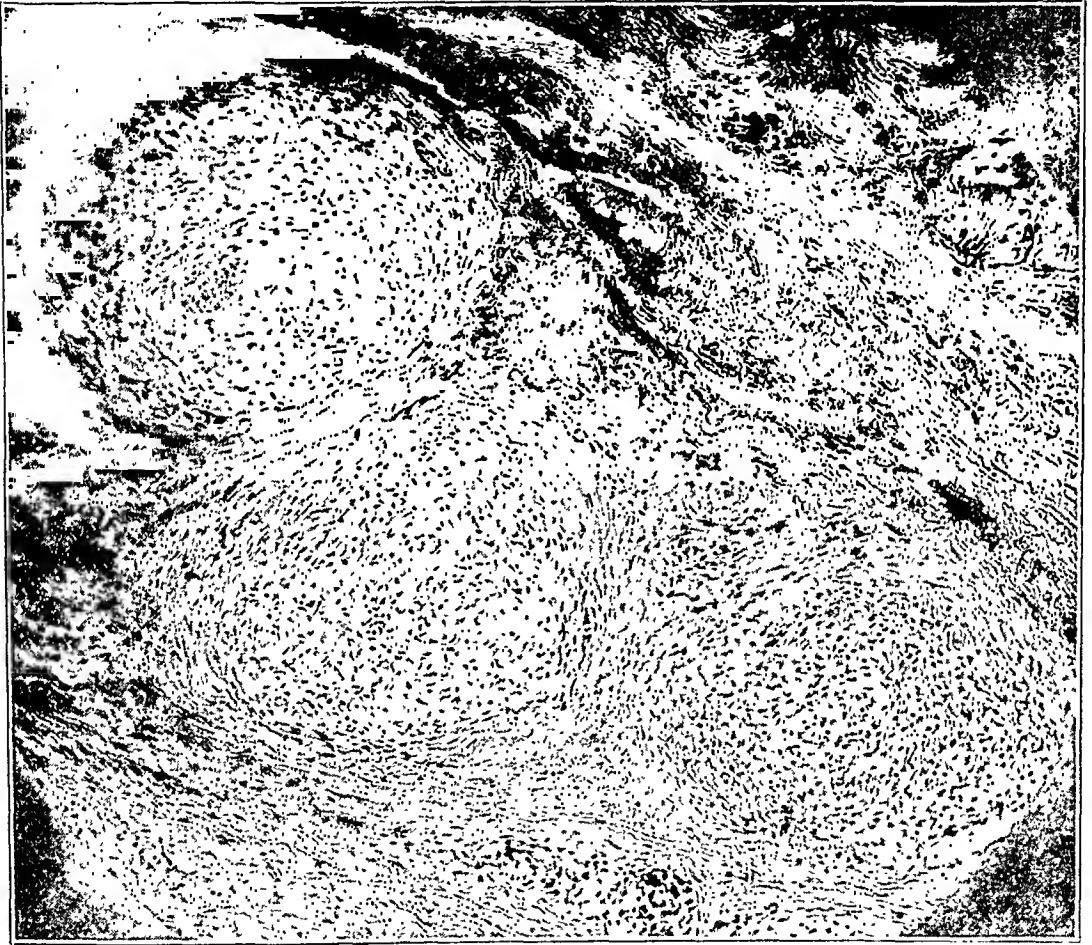


Fig. 7.—Plexiform degeneration of the ciliary nerves.

mollusca fibrosa and some subcutaneous nodules were also found. A molluscum fibrosum and a nodule were removed and studied microscopically. They showed the typical changes of neurofibromas of this type. The mother had slight bilateral exophthalmos, which could not be attributed to thyroid disease. Her vision was 20/30, and the fields were normal. The disks were considered normal, though slightly pale.)

Increasing pallor of the nerve head and a slight increase in exophthalmos in the child's right eye seemed to warrant exploration for tumor of the optic nerve.

*Operation.*—An incision in the skin was made along the lower margin of the orbit, extending down to the bone, and the orbit was entered through the septum orbitale. The globe was drawn upward by a traction suture. The tissues of the





Fig. 8.—Small tumor on the ciliary nerve. Note the nerve entering and leaving the tumor.



Fig. 9.—Degeneration of the ciliary nerves. In the upper right side there is tumor-like thickening with a few intact myelinated fibers at the center of the tumor. In the lower right side are shown proliferation of connective tissue elements of nerve and degeneration of nerve fibers. In the upper left side is shown a transverse section of partly degenerated nerve and in the lower left side, normal nerve (Weigert's stain).

orbit were pushed aside by packing, and the nerve was isolated without detachment of the extraocular muscles. The anterior half of the nerve was excised after being tied off at each end. Exploration was more difficult than in several other cases in which I had used this method of approach for orbital tumors, but nothing abnormal could be seen or palpated in the orbit. The optic nerve was not appreciably enlarged, but microscopic study later revealed a glial proliferation or early glioma throughout the excised portion of the nerve. (Autopsy four and one-half years later confirmed the diagnosis of tumor of the optic nerve, since a more advanced gliomatous growth had developed in the remaining portion of the nerve.)

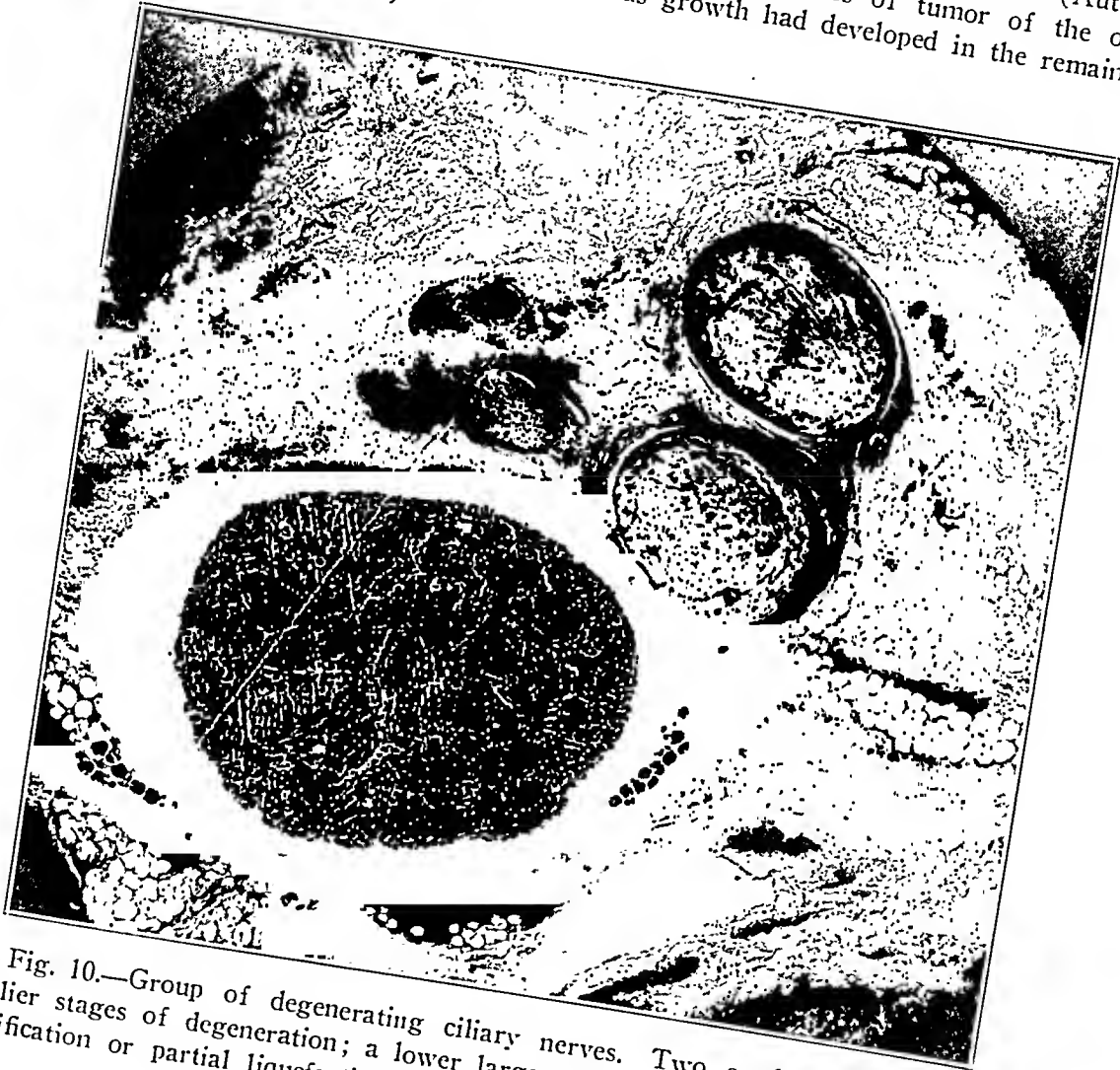


Fig. 10.—Group of degenerating ciliary nerves. Two small nerves are in earlier stages of degeneration; a lower large nerve has advanced to a stage of jellification or partial liquefaction (Antoni, type B).

*Postoperative Observations.*—The inflammatory reaction incident to exploration of the orbit rapidly subsided. The incision in the skin healed promptly. The eye, at first somewhat proptosed from the general reaction which followed the operation, assumed its normal position within three weeks, with a return of complete motility of the globe. The cornea appeared smooth and glistening. No trophic change developed. Since a corneal opacity had developed in a similar case in which operation had been performed, the lids were sutured at the time of operation and allowed to remain so for ten days. The pupil was well dilated from atropine, which was used throughout the healing period.

The child was observed at intervals for more than four years. The general appearance of the globe remained excellent. In a note made nine months after the first admission, I recorded a widening of the palpebral fissure and persistence of a slight exophthalmos. The globe appeared slightly larger than the fellow eye, and measurements revealed a slight increase in the vertical and horizontal diameters of the cornea. The importance of this observation was not appreciated at the time because the change was so slight. The asymmetry of the pupil gradually increased until it was finally drawn far to the temporal side, resembling a pear-shaped coloboma (fig. 6). The surface of the iris appeared uneven, and the

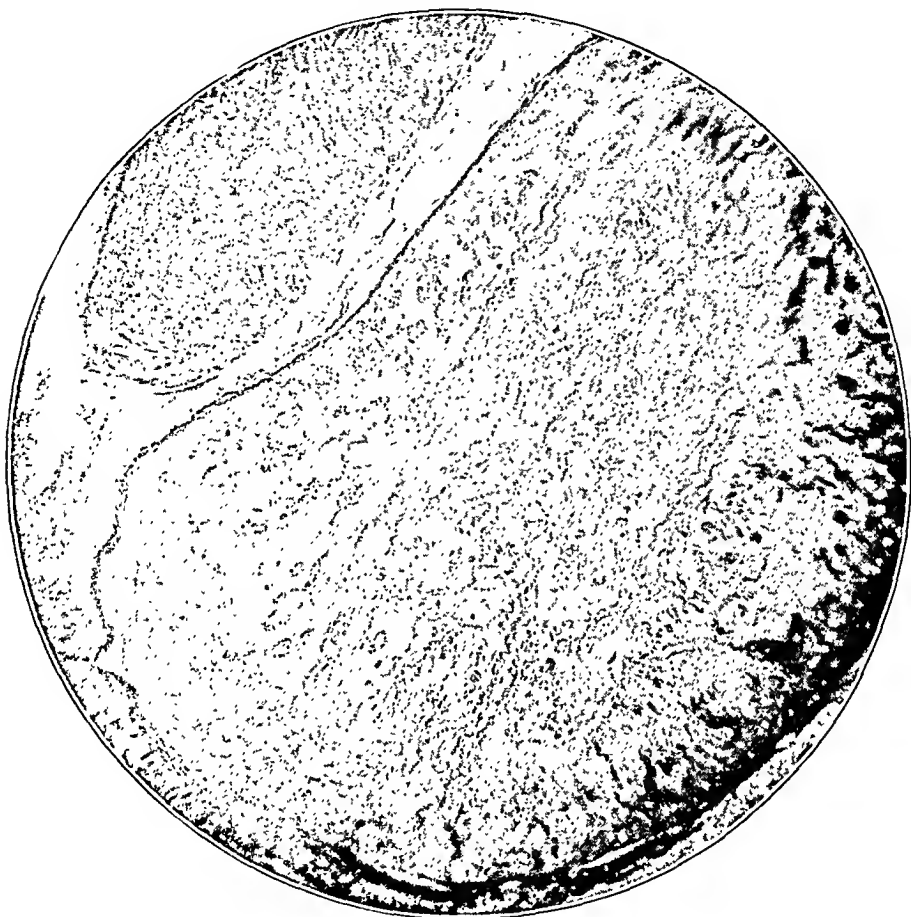


Fig. 11.—High power magnification showing detail of two tumors in a state of almost complete liquefaction (Antoni, type B, reticular "neurinoma").

color faded to a light gray. The pupil was slightly larger than that of the left eye, measuring roughly 4 by 5 mm.

The cornea remained clear until about six months before the child's death, when it showed a faint haze in the lower third due to a light gray infiltrate in the outer layers of the stroma. The epithelium was smooth and glistening. The right cornea was sensitive, but apparently less so than the left. The anterior chamber was slightly deeper than that of the fellow eye but not noticeably deeper than normal. The lens and vitreous remained clear except for a few coarse floating opacities of the vitreous, which were noted the last year the patient was under observation.

The fundus showed a pigmentary degeneration in the retina, which developed gradually. Large clumps of pigment were scattered over the retina, one large mass almost completely obscuring the disk. All normal outlines of the disk finally disappeared, a white spot only remaining behind the pigment. The vessels disappeared completely. There were no hemorrhages, but white patches appeared throughout the retina, intermingled with the pigment. The color of the fundus reflex was definitely paler than normal.

The motility of the globe was unaffected by the operation. A slight exophthalmos, about 3 mm., persisted (fig. 6), and a fulness of the upper lid was

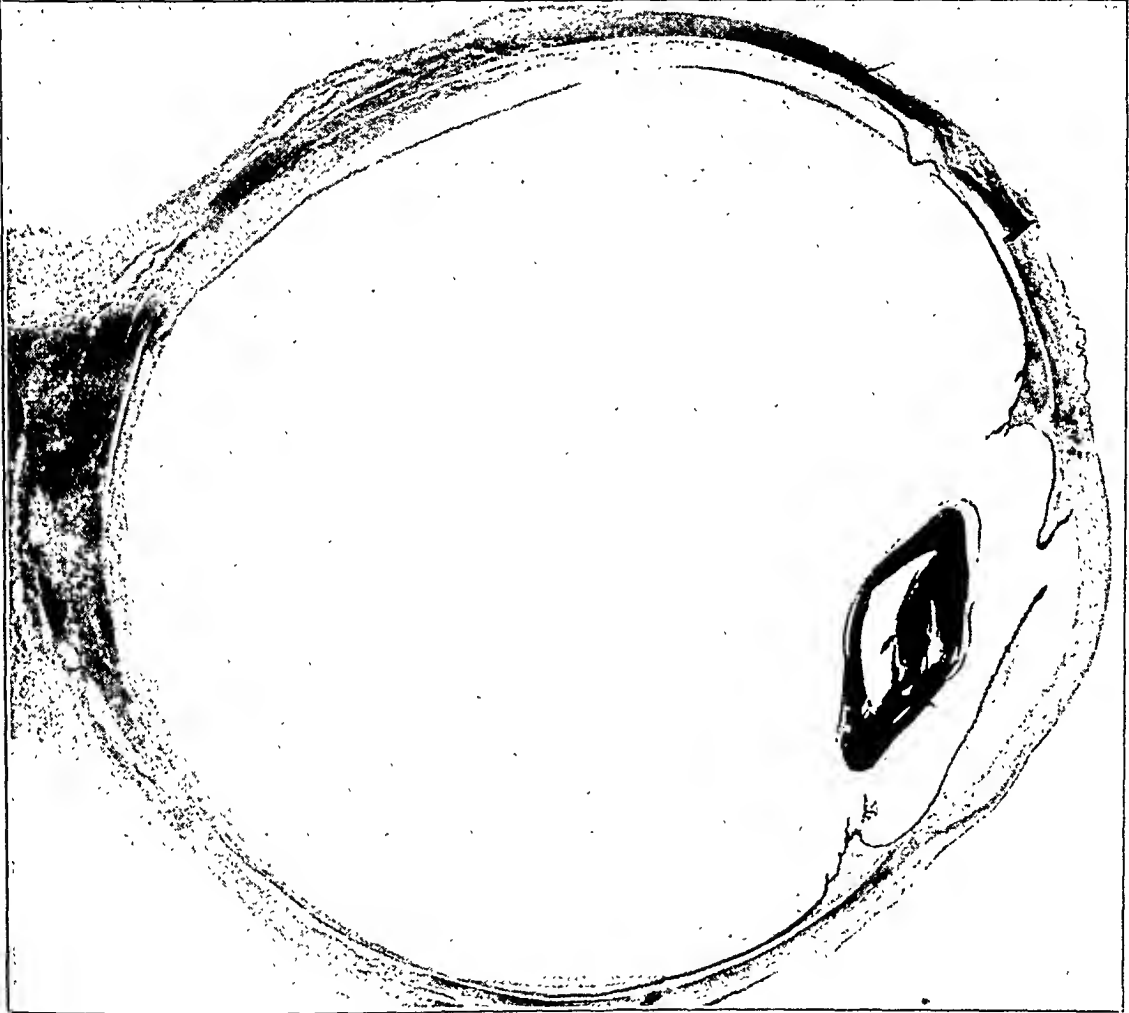


Fig. 12.—Horizontal section of the globe. Note the slight enlargement, blocked filtration angle, thickened choroid, atrophy of the retina and thickened sclera, especially the posterior segment where swollen nerves are seen.

noted from time to time, but no mass of any kind could be felt in any part of the orbit. There was no bruit or pulsation. A slight ptosis remained, as observed before operation. Tactile tension was repeatedly taken, but no definite elevation could be detected.

The left eye appeared normal to external examination, but visual acuity gradually fell to 20/70, with increasing pallor of the disk. The fields were contracted, but accurate measurements were impossible.

Later roentgen studies showed enlargement of the optic foramina, more marked on the right side. A lateral stereoscopic roentgenogram of the skull revealed a necklike, pear-shaped shadow which extended from the upper edge of the body of the sella turcica, under the anterior clinoid process. This shadow gradually increased in size. Digital impressions appeared throughout the vault. There was no definite increase in the size of the right orbit, nor was there any sign of erosion of its walls. The skull gradually enlarged from normal growth.

The child died four and one-half years after she was first examined, after an exploration for tumor of the brain. Autopsy revealed a glioma of the optic nerve and temporal lobe of the brain and areas of gliosis throughout the brain and the intracranial portion of both optic nerves. The microscopic study of the optic nerve and brain have been described in another paper. This communication is, therefore, limited to a description of the globe and contents of the orbit, excluding the nerve.

*Preparation of Specimen.*—The globe, including the orbital contents, was removed in toto at autopsy. The specimen was first placed in 10 per cent dilution

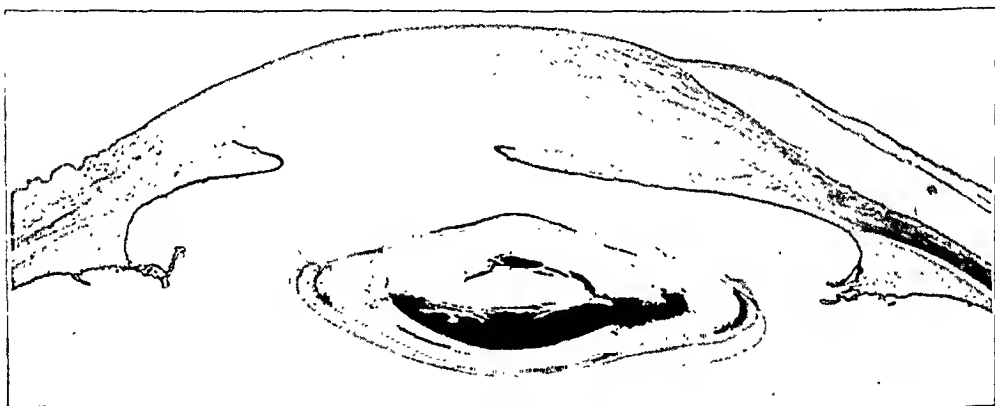


Fig. 13.—Detail of the anterior segment shown in figure 12. Note the blockage of the filtration angle with atrophy and contraction of the iris on one side. There is neurofibromatosis of the ciliary body and root of the iris.

of formaldehyde U. S. P. The globe was severed from the surrounding tissues, and the orbital contents, undisturbed by dissection, were cut transversely in three pieces. Part of the outer tissues were later removed, and sections of the specimen were refixed in Zenker's solution. Various staining methods were used, including hematoxylin and eosin, van Gieson's stain, Mallory's phosphotungstic acid and hematoxylin stain, Weigert's and Weil's myelin sheath stains, Masson's trichrome stain, the gold and silver technic of Cajal and Hortege, Weil-Davenport's modification and Unna's and Verhoeff's elastic tissue stains.

*Contents of Orbit.*—*Microscopic Study:* The orbital tissue immediately adjoining the posterior end of the globe was made up of a tangled mass of connective tissue with numerous nerves and blood vessels. The nerves, cut transversely, appeared as lobulated masses or whorls and were swollen and degenerated (fig. 7). Most of them failed to take the myelin sheath stain, while others stained in isolated areas of the nerves (fig. 9). The swollen nerves consisted of an overgrowth of cells with long, oval and spindle-shaped nuclei, with irregular wavy strands of collagen. Farther back in the orbit, surrounding the unremoved section of the

optic nerve, the tissue was made up of fat, muscle, nerves and blood vessels. Cells with spindle-shaped nuclei were scattered between the muscle bundles, and some of the finer nerve branches were swollen and degenerated. Many of the smaller vessels were hyalinized; some were completely occluded. There were marked changes in most of the nerves. Some of the larger ones toward the periphery of the specimen appeared normal, but others were degenerated. The ciliary nerves immediately surrounding the optic nerve showed varying stages of involvement.

Multiple small tumors were found along the course of many of these nerves. Most of them were microscopic in size, but some could be seen macroscopically. These tumors appeared as circumscribed, thickened areas along the course of a

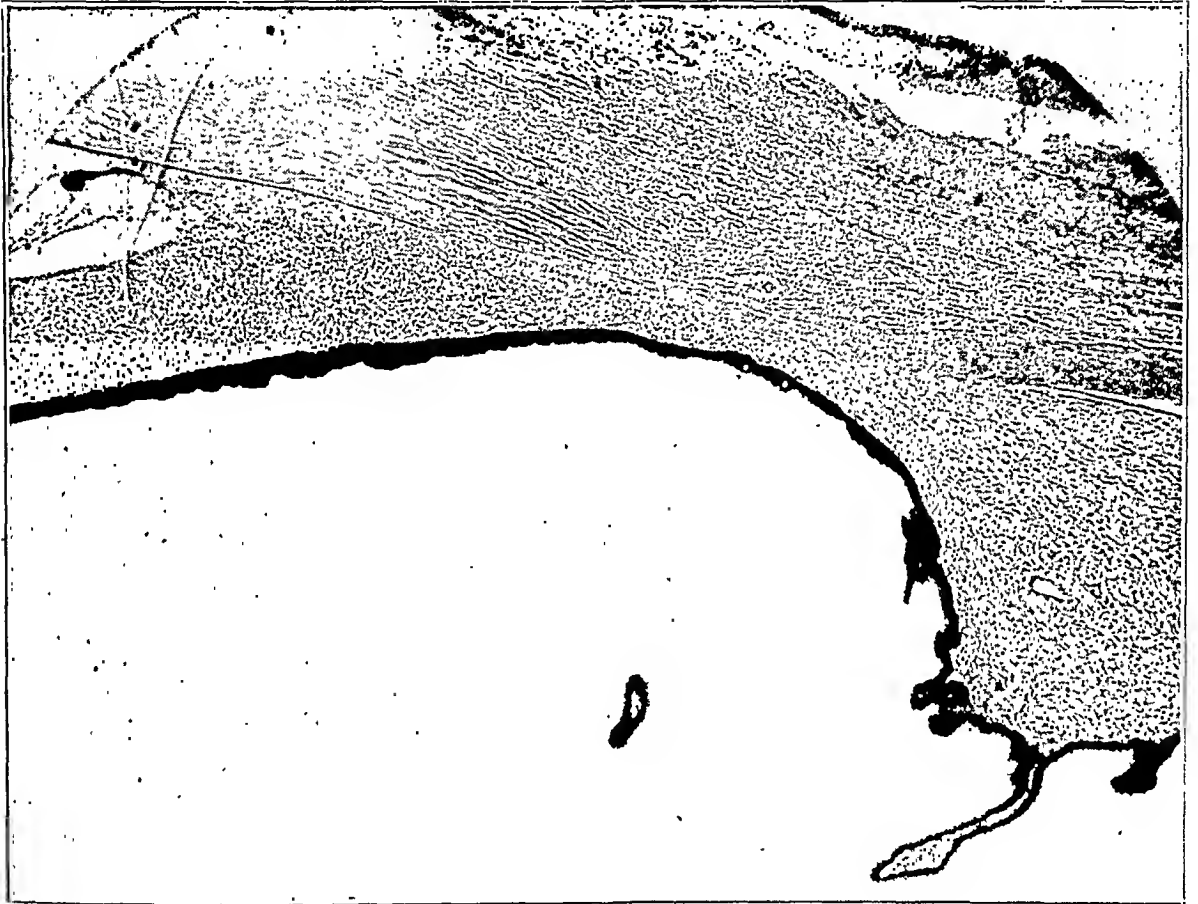


Fig. 14.—Region of the filtration angle. Note the adhesion of the iris to the posterior surface of the cornea. There is neurofibromatosis of the iris and the ciliary body. Schlemm's canal is present in this section.

nerve which otherwise seemed fairly normal. Figure 8 shows one of these tumors with the nerve entering and leaving it. Many of the ciliary nerves in the region surrounding the entrance of the optic nerve to the globe, which were cut transversely, showed marked thickening, apparently due to proliferation of all the elements of the nerve. Some were mildly affected; others were in a more advanced stage of degeneration. In longitudinal sections some of the nerve fibers showed what appeared to be an early stage of degeneration with a breaking up of the myelin into globular masses and a marked proliferation of the sheath cells and surrounding connective tissue. The nuclei of some of the cells were long and

slender, with slightly rounded ends; others were more spindle shaped and wrinkled or crenated. The former bore a striking resemblance to Schwann's cells, depicted by Masson<sup>4</sup> in his article on experimental and spontaneous schwannomas. The other cells appeared to be fibroblasts. Some of the tumors had the appearance of a reaction process about the nerve fibers which had degenerated (fig. 9). Others were in an advanced stage of degeneration and presented many of the characteristics of the "reticular type of neurinoma," designated by Antoni<sup>5</sup> as type B (fig. 10). In one tumor this degeneration only partially involved the nerve, the

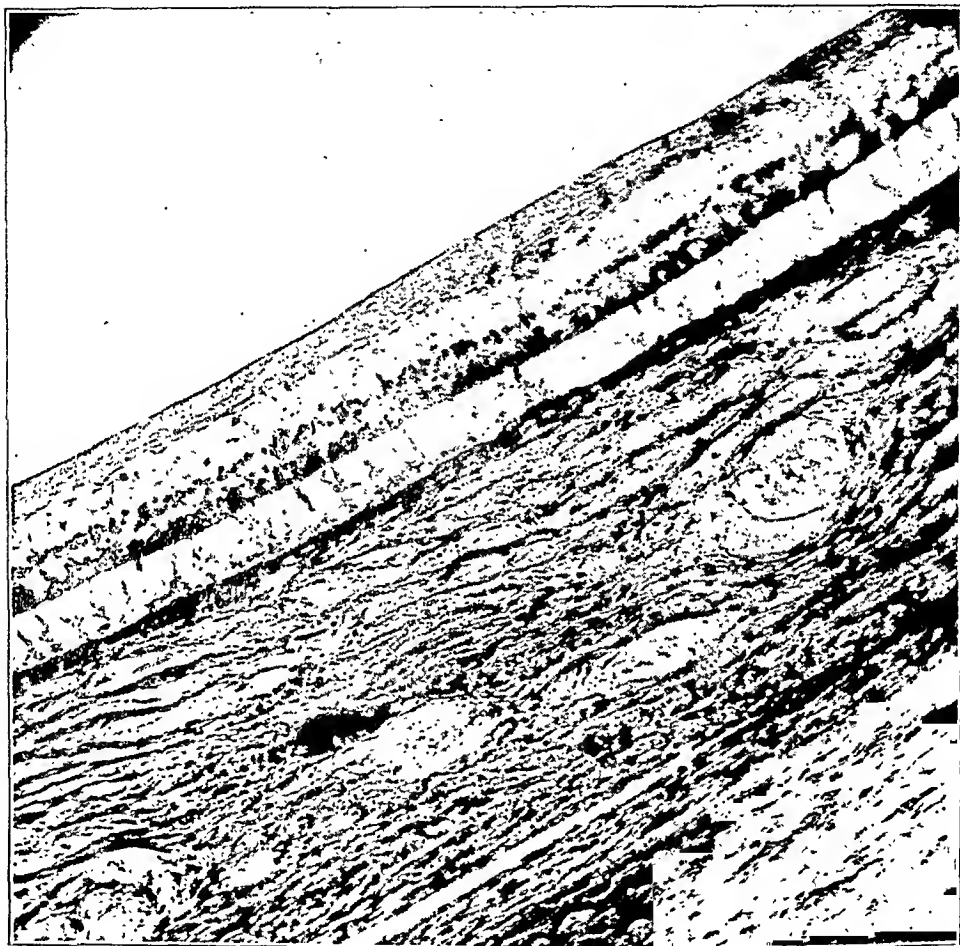


Fig. 15.—Plexiform degeneration of the nerves of the choroid. The retina is present though partially atrophied.

central core consisting of well stained fibers with intact myelin sheaths, while surrounding this and distending the perineural sheath there was a partially jellified mass. One tumor (fig. 11) was in a state of almost complete liquefaction, in which isolated long spindle cells with wavy processes extending from each end

4. Masson, P.: *Am. J. Path.* 8:367, 1932.

5. Antoni, N.: *Ueber Rückenmarkstumoren und Neurofibrome*. Munich. J. F. Bergmann, 1920.

and a few isolated strands of hyalinized tissue were embedded. No palisading was observed in any of these tumors, though one area of palisading was found in a mass of proliferated cells which invaded the tissues immediately behind the globe adjoining the sclera.

The ciliary ganglion showed changes similar to those found in some of the ciliary nerves. The ganglion was roughly triangular and measured 3 by 4.5 mm. It was surrounded by a fairly dense sheath of connective tissue. Numerous nerves were seen entering and leaving the ganglion. Many of these were fairly normal in appearance, their myelin sheaths staining well. Immediately on entering the ganglion most of the nerves became highly degenerated, all traces of the normal fibers disappearing. Other small bundles, however, remained strikingly normal for a considerable part of their course through the ganglion. One area in the ganglion appeared to be a cross section of a large nerve in the earlier stages of



Fig. 16.—Marked thickening of the choroid with an atrophic retina, thickened sclera and proliferating thickened nerve entering the choroid.

degeneration. The main body of the ganglion consisted of irregular masses of degenerating nerve fibers and wavy strands of hyalinized tissue running in various directions. Embedded in this mass were numerous ganglion cells. They were oval or round and surrounded by a laminated, nucleated tissue resembling connective tissue. The nuclei of this capsule were mostly of a short oval form, though some were perfectly round, the latter being hyperchromatic with mitotic figures present in some. The ganglion cell itself consisted of a large faintly staining homogeneous body, slightly granular, with a typical large round nucleus which contained one large deeply stained nucleolus. Some of the ganglion cells were encroached on by the round cells which bordered them and in some places were completely replaced by nests of cells with round nuclei. A small accessory ganglion similarly affected was found adjacent to the main ganglion.



*The Eye.*—The globe appeared definitely larger than normal, measuring 26 by 24.5 by 24 mm. (fig. 12). The cornea measured 10 by 11 mm., was normal in shape and appeared smooth. The lens was in normal position; the vitreous appeared normal; the choroid was much thickened, especially at the posterior pole of the eye. A mass of pigment could be seen at the site of the nerve head.

*Microscopic Examination:* The eye was sectioned serially in the horizontal plane. The corneal epithelium appeared normal over the upper part of the cornea, but in the lower half it was somewhat thickened in places. The deeper



Fig. 17.—Enlarged long ciliary nerve penetrating the sclera. Note the neurofibromatosis of the ciliary body.

cells were swollen, some being vesicular and others goblet shaped. In the upper half Bowman's membrane was intact and appeared normal, but in the lower half it was partially destroyed on either side near the limbus due to the invasion of cells with oval nuclei. A few small blood vessels were present in this tissue. The outer layers of the stroma showed a similar invasion of cells, though they were neither numerous nor dense. The deeper layers of the stroma were normal. Descemet's membrane was present and had the usual smooth contour throughout its entire length. The endothelial cells were swollen in places. The filtration angle was completely blocked by an adhesion of the root of the iris to the posterior surface of the cornea (fig. 13). Schlemm's canal and the region of

the pectinate ligament appeared to have been largely replaced by newly formed tissue made up of cells with oval nuclei. In some areas spaces were present at the site of the canal which contained blood cells and newly formed tissue (fig. 14). It was impossible to determine definitely whether these were blood vessels or remnants of the canal.

The iris varied considerably in appearance in different sections. The pupil was drawn far to one side, where only a short nub of the iris remained, which was

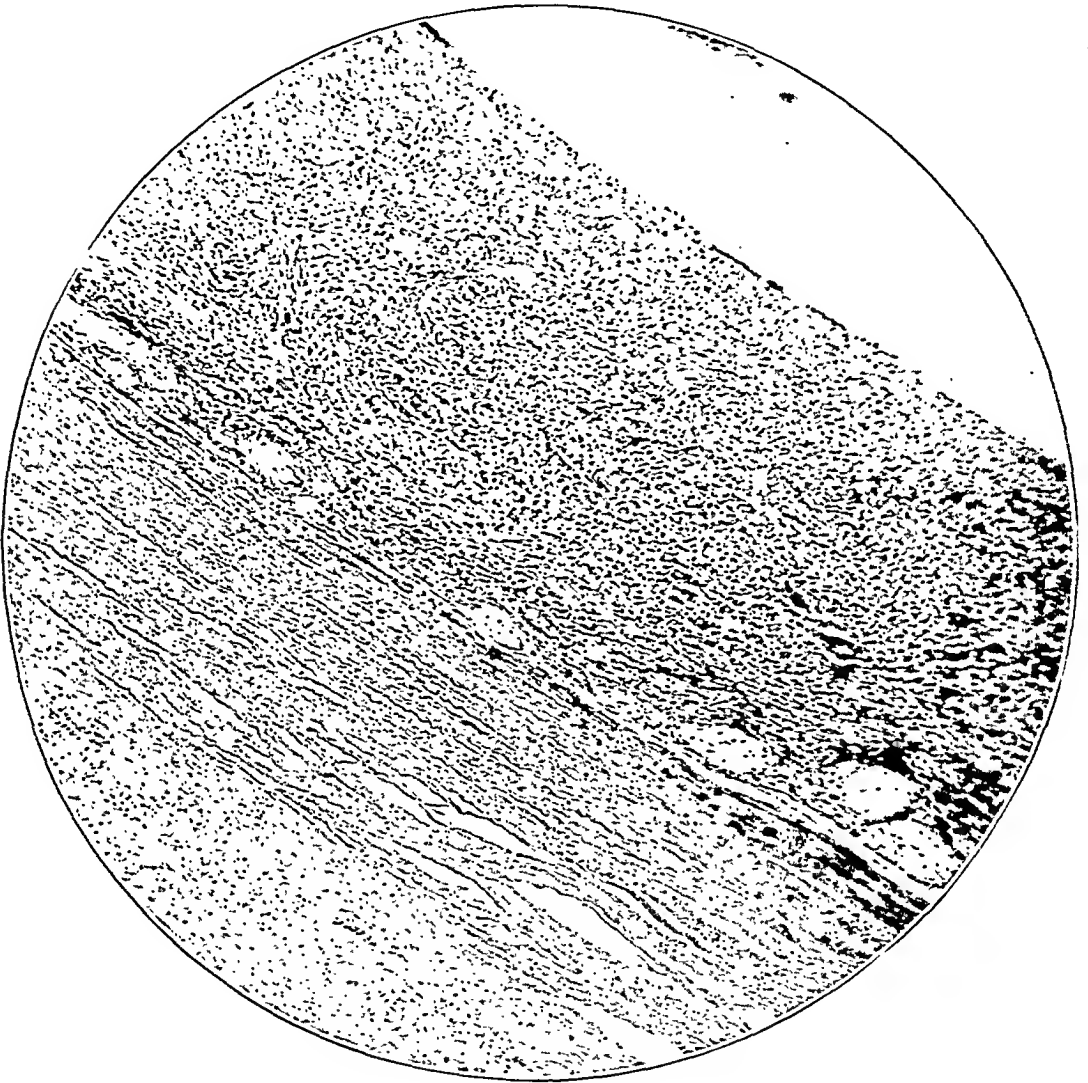


Fig. 18.—Thickened choroid with ovoid bodies. Most of these are transverse sections of proliferated nerves.

composed of connective tissue and the sphincter muscle. The pigment epithelium in this region extended completely over the anterior surface of the iris to the angle and terminated on the cornea. The iris tissue in this region was largely replaced by connective tissue and tissue made up of cells with long oval nuclei. The iris was much wider on the opposite side, owing to marked overgrowth of the stroma. It was much thickened in places and in one area showed a tumor-like mass. This was made up of proliferated chromatophores, mostly nonpigmented, and some long spindle cells.

The retina was profoundly altered and thinned out but was in normal position, showing only slight separation in places due to fixation (fig. 16). It was highly degenerated for the most part, but in many areas the various layers could be easily identified. The layers were more normal in appearance in the region beyond the equator, approaching the ora serrata (fig. 15). No ganglion cells could be found. Rods and cones could be identified in the more normal appearing areas, but they were degenerated. Pigment masses from the pigment epithelium were scattered through various parts of the retina, arranged in small clumps. Several small areas of bone formation were found in the retina and also in the choroid and sclera. The pigment epithelium was present throughout almost its entire course. In many areas the cells were swollen and broken up, the pigment granules

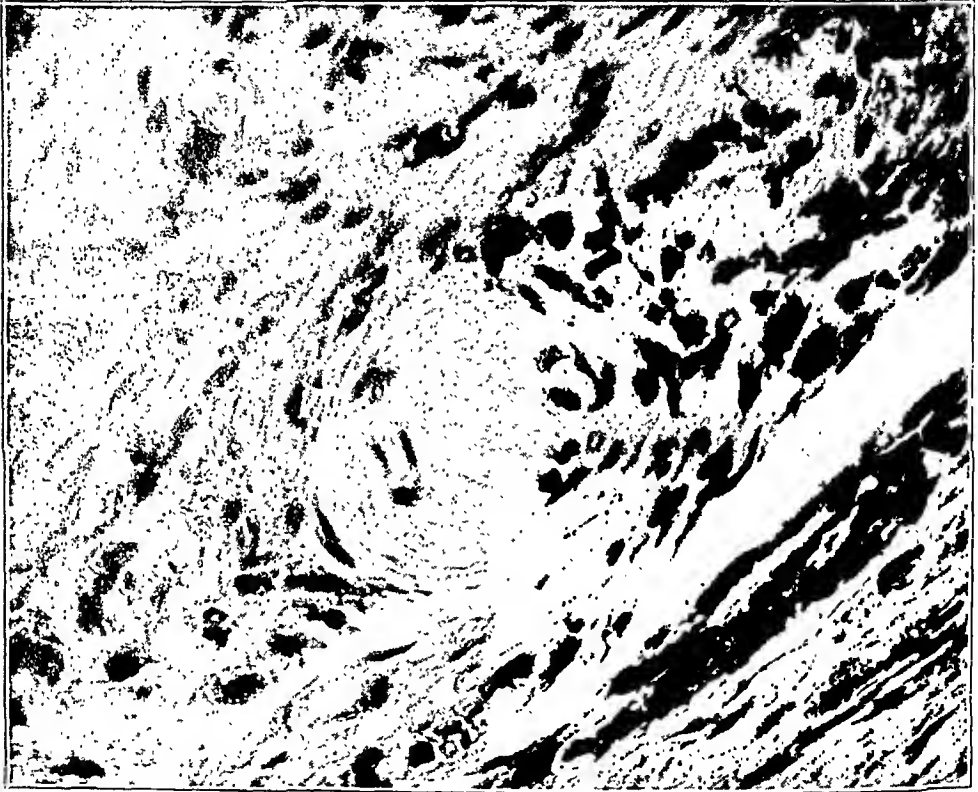


Fig. 19.—Ovoid body in the choroidal tumor. These bodies are probably sensory end organs, similar to meissnerian corpuscles. They also resemble Krause's conjunctival corpuscles.

having spread to surrounding parts. In most places some pigment was present in the cells. There were hardly any blood vessels to be found in any part of the retina. Persistent search, however, revealed a few in the deeper layers of some sections.

The disk was replaced by a mass of proliferated retinal tissue in which large clumps of pigment had wandered, though all normal outlines had vanished. The site of the disk could be identified only by the termination of the thickened choroidal layer on either side of the proliferated mass of tissue which replaced it

The choroid was much thickened, being more than four times its normal thickness in the region posterior to the equator (fig. 16). It was thickest on either side of the disk and gradually became thinner as it approached the ciliary body. The normal tissue of the choroid was replaced by a marked overgrowth of the fibrous elements and proliferated nerves. The tissue was arranged in dense layers in which spindle-shaped nuclei were embedded. These nuclei appeared in parallel rows and presented the appearance so well described by Penfield<sup>6</sup> as "streams" or "currents" flowing through the tissues. The picture might be more graphically described as schools of minnows swimming in the current, since this

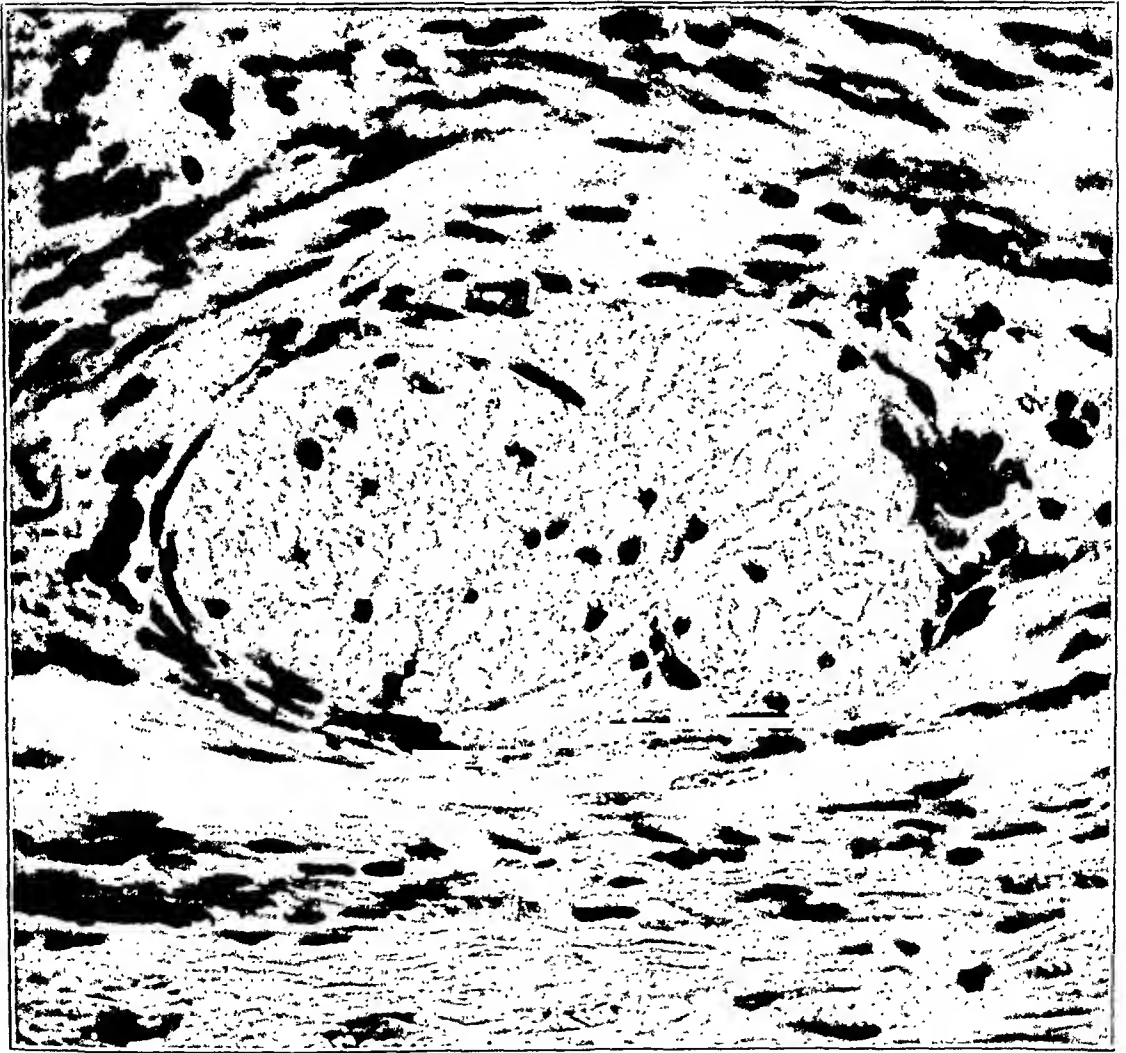


Fig. 20.—Ovoid body: a transverse section of an enlarged nonmyelinated nerve of the choroid. Note the streams of spindle-shaped cells which make up the main body of the tumor of the choroid and the long nonmyelinated nerve below (horizontal section) with long spindle-shaped cells.

is the impression one receives when typical areas are studied. No definite palisading was present. Blood vessels, smaller than usual and fewer in number, were present throughout the newly formed tissue. Pigment was confined almost entirely

6. Penfield, W.: *Cytology and Cellular Pathology of the Nervous System*, New York, Paul B. Hoeber, Inc., 1932, vol. 3, p. 955.

to the deeper layers, where it was definitely reduced in amount in most places. Several thickened myelinated nerve fibers could be traced as they pierced the scleral wall and entered the suprachoroidea. Some of these nerves could be followed in places as they progressed through the choroid, while others were

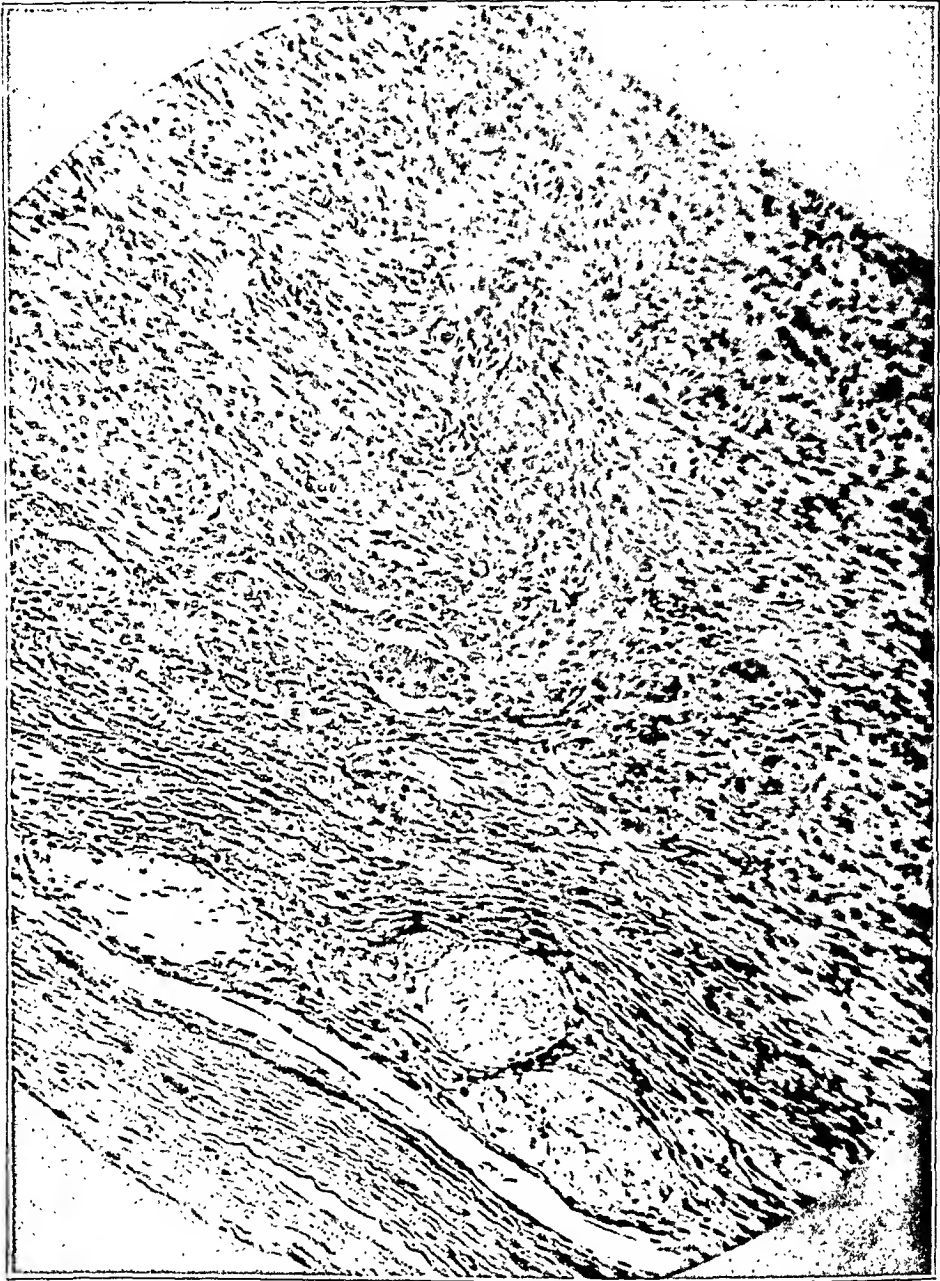


Fig. 21.—High power magnification of the section in figure 18. Neurofibromatosis of the choroid. Note that the choroid is replaced by masses of spindle-shaped cells. Also note the ganglion cells and three large nerves cut transversely.

lost in masses of proliferated spindle-shaped cells. Two long ciliary nerves could be traced to the anterior part of the choroid, where they pierced the scleral wall behind the scleral spur and continued on toward the corneoscleral border, where they broke up and were lost (fig. 17).

Numerous round, ovoid and more elongated bodies which varied somewhat in appearance were embedded in the deeper layer of the choroid (figs. 18, 21 and 22). They appeared almost colorless when stained with hematoxylin and eosin, but sometimes they were a pale pink. It was impossible to stain them intensively

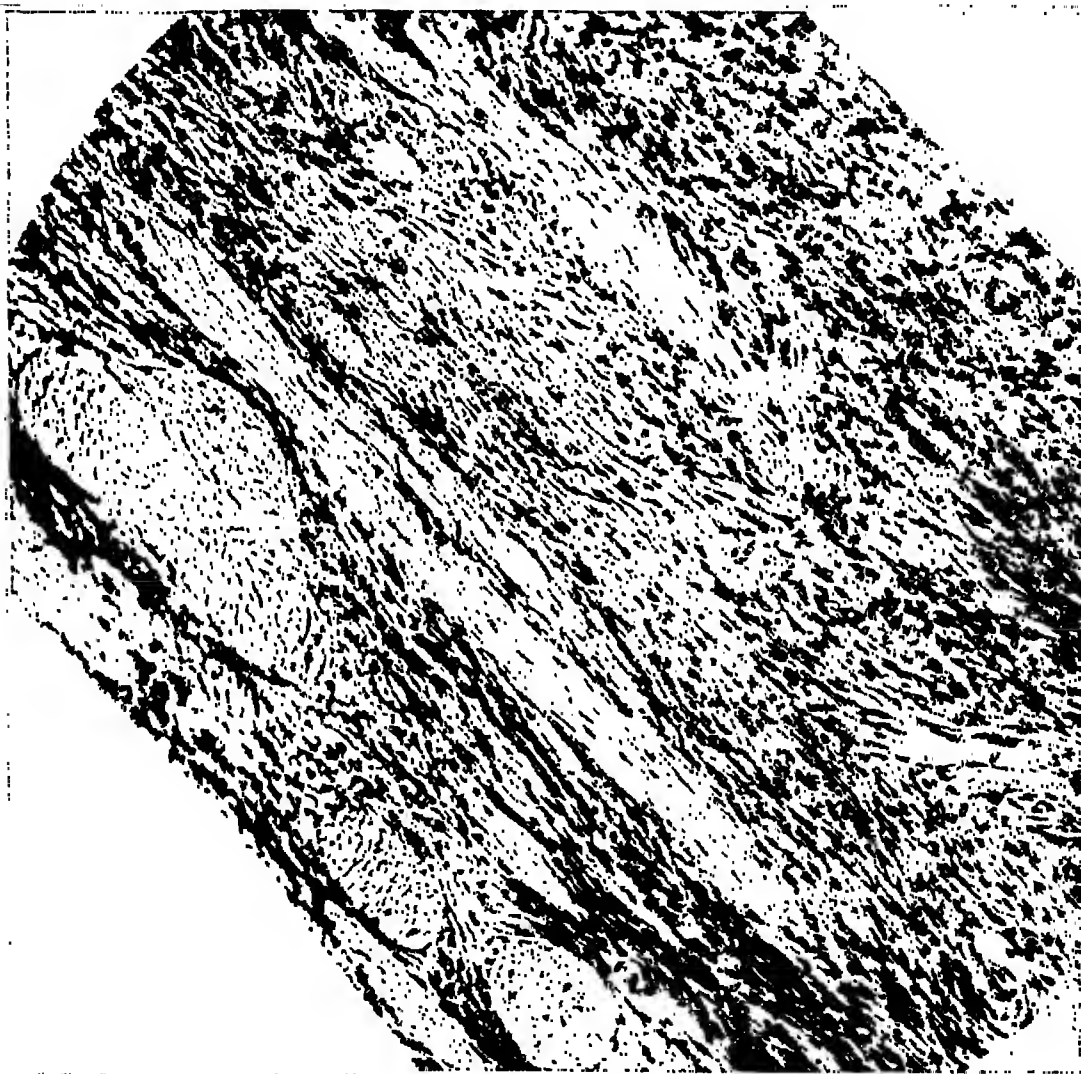


Fig. 22.—Choroid. This section shows a different area of the thickened choroid. Note the longitudinal as well as the transverse sections of enlarged nonmyelinated nerve fibers.

with any method, but with special stains the color of the tissue resembled that of myelinated nerves. Van Gieson's stain gave a pale yellow tint, Mallory's phosphotungstic acid and hematoxylin stain a light blue and Masson's trichrome stain the characteristic reddish pink, though of a much lighter hue than that of normal myelinated nerves. A few of these bodies were definitely laminated, with a suggestion of palisading of the nuclei at each end (fig. 19). Most of them, however, showed a delicate network with an occasional small irregularly-shaped

nucleus in the center or a more spindle-shaped nuclear form at the periphery. In some the network was characterized by definite partitions, resembling the cross section of a nerve (fig. 20). They were not definitely encapsulated, though they were sharply delimited. In the elongated bodies the tissue appeared like delicate translucent fibers in which an occasional spindle-shaped nucleus was embedded. In places they were arranged in long strands and appeared to be thickened, nonmyelinated nerves (figs. 20 and 22). Toward the equator the sharply circumscribed bodies became even more numerous, and the entire area

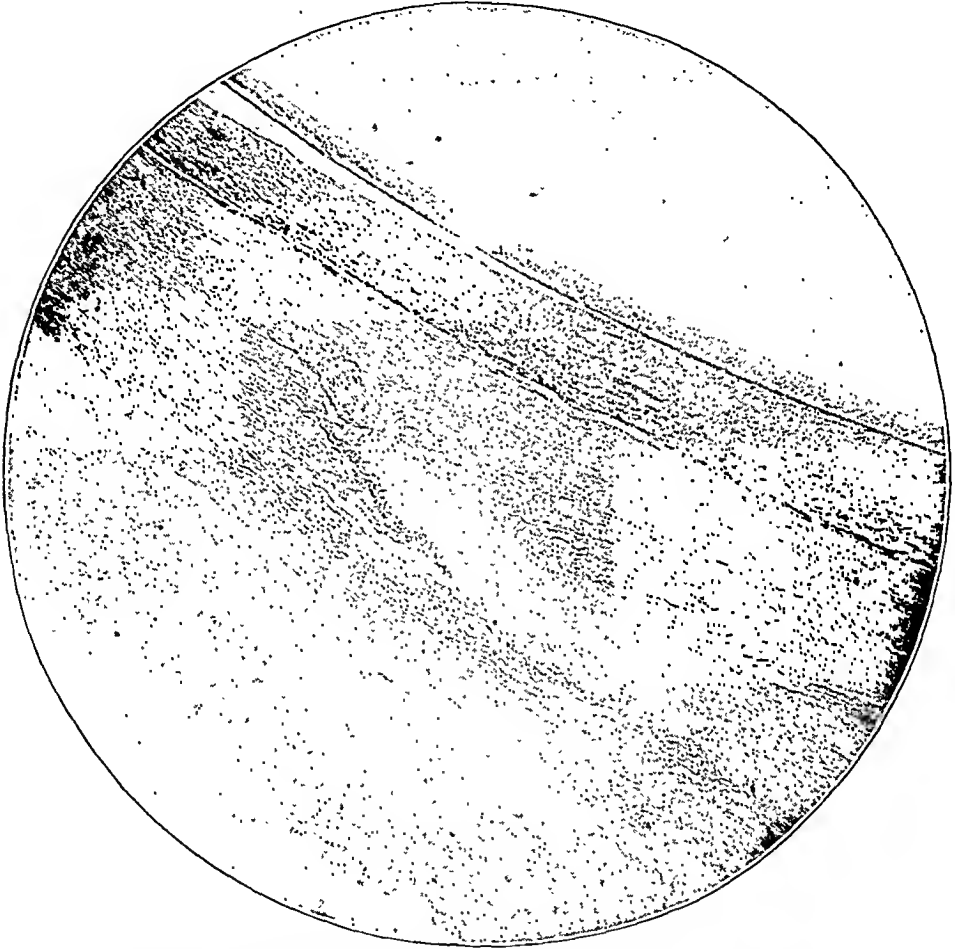


Fig. 23.—Much enlarged degenerated nerve in the sclera. (Choroid and retina above.)

of the choroid in places was transformed into a meshwork of them (fig. 15). Numerous ganglion cells, appearing singly and in clumps, were scattered throughout the choroid (fig. 21).

The ciliary body was somewhat thickened due to an increase in spindle cells. Myelinated nerves could be traced into the ciliary body for short distances. The cells with spindle-shaped nuclei extended to the root of the iris and in some areas seemed to invade certain parts of it. On the whole, however, the iris was much less affected by the new tissue growth than the choroid or the ciliary body.



The sclera was much thicker than normal. Several ciliary nerves, much enlarged and highly degenerated, pierced the sclera on either side of the nerve. Long sections, longitudinally cut, could be traced as they entered the scleral wall and proceeded to their entrance into the suprachoroidea (fig. 23). Another much thickened nerve entered the choroid beneath the site of the disk. It could be traced through the sclera, and on its entrance to the choroid it broadened out; the new growth of the choroid appeared to bulge out into the sclera where it merged with the thickened nerve. In places the nerve resembled a scleral nerve loop, but serial sections showed that it was not a true loop but a neurofibromatosis of a ciliary nerve, with a kind of ectasia of the new growth of the choroid (fig. 16).

Immediately outside the sclera, in the region formerly occupied by the optic nerve, there was a dense mass of connective tissue. Elastic fibers were especially numerous in this region. There were numerous ciliary nerves, cut transversely, which showed a fairly advanced degeneration (fig. 7). Most of these appeared to be myelinated. The myelin sheaths were degenerated for the most part, but isolated patches within the swollen nerves stained well (fig. 9). Numerous hyalinized blood vessels were also encountered.

The lens and vitreous appeared normal, though an occasional large mononuclear cell was found in the latter. There was a definite increase in the size of the circumlental space. The zonular fibers appeared thinned and elongated.

#### COMMENT

Since plexiform neurofibromatosis of the orbit and globe has been a subject of recent discussion before the society, I shall limit my remarks to special features of this case.

It is noteworthy that the enlargement of the nerves within the orbit was not clinically demonstrable. A slight ptosis and fulness of the upper lid were present, but no mass, cordlike or otherwise, could be palpated. Some exophthalmos persisted after removal of part of the optic nerve, which was no doubt due in part to plexiform changes in the other nerves. While most of the ciliary nerves were enlarged, with definitely circumscribed tumor formation in places, these changes were chiefly microscopic. Many of these areas appeared like a reaction process about the nerve. Penfield<sup>6</sup> has emphasized the fact that the appearance of the tumors in general in Recklinghausen's disease are more like a reaction about nerve fibers than a neoplastic growth. This is well illustrated in figure 9. Many of the larger tumors strikingly resembled the neurofibromas of Recklinghausen's disease as described by Penfield. He stated they are made up of tangled reticular tissue in which the nuclei are not arranged in any particular order and in which there is an obvious confusion of connective tissue, which he aptly referred to as a "patternless arrangement." In the more advanced stage of these growths degeneration takes place with the production of a gelatinous tissue and isolated strands of hyaline and tail cells. This type corresponds to Antoni's type B "neurinoma," according to Penfield. A number of



the tumors in this case were typical examples of this advanced stage (figs. 10 and 11). Penfield also emphasized the difference in the neurofibromas of Recklinghausen's disease and perineurial fibroblastomas (sometimes called schwannomas), palisading of the nuclei being a characteristic feature of the latter. The origin of these various tumors is still a subject of controversy among pathologists.

The general appearance of the globe was such that early buphthalmos was not suspected. The only striking abnormalities were the distortion of the pupil and the atrophy of the iris. The asymmetry of the pupil increased gradually during the time the child was under observation. This irregularity in the shape of the pupil, especially if progressive, may be of help in early diagnosis of some of these atypical cases. The pear-shaped deformity, resembling a coloboma, has been observed and described by others (Snell and Collins<sup>7</sup>). I have observed a similar deformity of the pupil in another case of glioma of the optic nerve and Recklinghausen's disease in which the iris was much thickened, though the histologic structure was not typical of neurofibromatosis. It is possible in this case that involvement of the iris and choroid was in an early stage. Lisch<sup>8</sup> reported 3 cases of Recklinghausen's disease with nodules in the iris and variations in pigmentation.

The newly formed tissue in the choroid and ciliary body evidently arose from myelinated and nonmyelinated nerves. Theobald,<sup>9</sup> in her recent work concerning the neurogenic origin of sarcoma, has emphasized the rich nerve supply of the choroid and cited the work of numerous investigators in this connection.

One encounters relatively few nerves in ordinary preparations of normal eyes within the body of the choroid, though occasional ganglion cells are seen. Unmyelinated nerve fibers are so fine they are not usually seen with ordinary stains. In serial sections of this eye, however, it would appear that the posterior layers of the choroid were literally riddled with nerves. Since the nerves were much enlarged, due to neurofibromatosis, the whole pattern of the nerves which supply the sclera and choroid were brought into view. Some of the nerves stained well with Weigert's stain and with iron hematoxylin as well as with Mallory's phosphotungstic acid stain. These were usually only slightly enlarged; others, particularly those within and adjacent to the sclera, were enormously enlarged and degenerated, and their myelin sheaths failed to stain except in limited areas.

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7. Snell, S., and Collins, E. T.: *Tr. Ophth. Soc. U. Kingdom* **23**:157, 1903. The histologic descriptions are by E. Treacher Collins.

8. Lisch, K.: *Ztschr. f. Augenh.* **93**:137, 1937.

9. Theobald, G. D.: *Neurogenic Origin of Choroidal Sarcoma*, *Arch. Ophth.* **18**:971 (Dec.) 1937.

The nonmyelinated nerves in the choroid were also much thickened and traversed most of this layer (fig. 22). They were thickest about the posterior pole of the eye. Toward the periphery the nerves were much thinner, but here they formed a fine honey-combed meshwork or plexus (fig. 15).

The newly formed tissue aside from the nerves was made up of cells with long pointed nuclei, probably proliferated cells of Schwann and Remak. Pathologists have not developed any satisfactory method of staining for these cells, so it is difficult to differentiate them from fibroblasts.

Most of the round and ovoid bodies appeared to be transverse sections of unmyelinated nerve fibers which had become thickened and enlarged from the neurofibromatosis which affected them. When this same tissue appeared in longitudinal sections it could be identified beyond question as thickened nerve fibers. Farther out toward the equator the plexus of nerves were more clearly shown, since the fibrous elements were less pronounced.

Collins<sup>7</sup> described ovoid bodies in a case of neurofibromatosis of the choroid which he reported and suggested they were pacinian corpuscles. He observed an occasional nerverlike structure entering or leaving them. Reese<sup>10</sup> described similar ovoid bodies in Wheeler's case, which he considered meissnerian corpuscles, while Knight<sup>11</sup> thought that they were hyalinized connective tissue. Friedenwald<sup>12</sup> also referred to these bodies and stated that they resembled pacinian corpuscles.

From various descriptions and illustrations depicting these structures, it is evident that there are at least two, and possibly three, distinct types. A few of the bodies in my case resembled meissnerian corpuscles, cut transversely to the long axis of the body (fig. 19). They also resembled Krause's conjunctival corpuscles. A few of these corpuscles were also found in the episcleral tissues. Most of the bodies found in the choroid were definitely of a different type. They were neither end organs nor hyalinized connective tissue but were evidently enlarged proliferated nerve fibers of the nonmyelinated type, cut transversely.

Since the optic nerve had been cut four and one-half years previously, no doubt some of the changes within the orbit and globe were the result of this, particularly the atrophy of the ganglion cells of the retina. The almost complete absence of retinal vessels and the destruction of the optic nerve in the scleral wall were also due to severance of the nerve, which was tied and cut close to the globe at time of operation. A tangled mass made up of hyalinized strands of tissue, nerves and pigment

10. Reese, A. G., in discussion on Wheeler.<sup>2</sup>

11. Knight, M. S.: *Am. J. Ophth.* 8:791, 1925.

12. Friedenwald, J., in Penfield,<sup>6</sup> p. 1063.

was the only indication of its former site within the scleral wall. Since proliferation of nerves with tumor-like growths sometimes follows cutting of a nerve, as described by Masson, the question might be raised concerning some of the tumors of the orbit in this case. However, changes within the globe, particularly the iris, were well developed before operation, and enlargement of the orbit was already present. Other evidences of Recklinghausen's disease were so widespread that it seems there could be no question that the orbital lesions were primary.

*Buphthalmos*.—The eye was symmetrically enlarged, though the typical cornea of hydrophthalmos or buphthalmos was not present. While the size of the cornea was not greater than that of the normal adult cornea, it was about 1 mm. larger in diameter than that of the left eye. This was not noted until about nine months after the child was first examined. The difference was so slight that its significance was not recognized at the time. Unquestionably early hydrophthalmos or buphthalmos was present at this time, though there was no further visible increase in the size of the cornea.

Other cases of neurofibromatosis of the choroid without any sign of buphthalmos have been reported (Freeman;<sup>13</sup> Callender and Thigpen;<sup>14</sup> Meeker<sup>15</sup>). In some of these cases atypical varieties of the disease were present. For instance, in the case of Callender and Thigpen there were two sharply circumscribed tumors, one in the iris and the other in the choroid near the disk. In Freeman's case there was limited involvement of the choroid, which he referred to as a discoid swelling of about 4 mm. around the disk, thickest at the point of entrance of the posterior ciliary arteries. All of the normal components of the choroid were present, though spread apart by fibers of neurofibromatous tissue. Meeker briefly referred to a "plexiform neuroma" of the choroid without enlargement of the globe, found in an eye which was enucleated for a corneal ulcer. The filtration angle was blocked by an adhesion of the iris, and the nerve was cupped. The patient was 41 years of age and showed no other evidence of Recklinghausen's disease. The absence of buphthalmos in some of these cases is interesting.

The cause of the buphthalmos associated with this disease remains uncertain. Collins attributed it to some congenital defect in the filtration angle and faulty formation of the spaces of Fontana, since he found a broad adhesion of the iris to the posterior surface of the cornea.

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13. Freeman, D.: Neurofibroma of the Choroid, *Arch. Ophth.* **11**:641 (April) 1934.

14. Callender, G. R., and Thigpen, C. A.: *Am. J. Ophth.* **13**:121, 1930.

15. Meeker, L. H.: Two Tumors of the Eye: (1) Amputation Neuroma of the Long Posterior Ciliary Nerve; (2) Plexiform Neuroma of the Choroid in a Nonbuphthalmic Eye, *Arch. Ophth.* **16**:152 (July) 1936.

Sachs'alber<sup>16</sup> suggested interference with lymphatic circulation, while Wiener<sup>16a</sup> considered the enlarged globe might be a part of the general hyperplasia which affected other structures, such as the bony orbit and face, and hypertrophy of the lid. Verhoeff<sup>17</sup> suggested that glaucoma arose from a disturbance in the metabolism of the eye brought on by disease of the ciliary nerves. Reese, in describing the eye in Wheeler's case, stated the filtration angle was completely obliterated, since there was an adhesion of the iris to the posterior surface of the cornea, though no mention is made of Schlemm's canal. Wheeler considered Collins' explanation of the cause of buphthalmos the most reasonable.

A broad adhesion of the iris to the posterior surface of the cornea was a striking feature of the case herein considered. Schlemm's canal was present in some sections, though in places this region was filled in by newly formed tissue. The pectinate ligament appeared to have been spaced out in the usual fashion, though the spaces were filled in by cellular tissue. The obliteration of the filtration angle may quite as well be secondary to the general hyperplasia of the supportive elements of the ciliary nerves as to a primary congenital defect in the filtration angle. If the adhesion of the iris to the cornea was due to congenital failure of separation of the tissues in the angle, it would appear that a much more advanced and definite type of buphthalmos would be present at birth or shortly thereafter in all of these cases. The case of Meeker, in which a patient advanced in years had a similar blockage of the filtration angle without buphthalmos, indicated that the condition was not of congenital origin.

It seems plausible that the marked thickening of the choroid and ciliary body may produce an anterior displacement of the uveal tract with subsequent adhesion of the root of the iris to the posterior surface of the cornea. The adhesion in this case was apparently augmented by newly formed tissue incident to the neurofibromatosis or proliferation of the ciliary nerves in this region. Subsequent enlargement of the globe would then develop in the usual manner from increased intraocular tension, if the lesion in the choroid developed early in life when the eye was distensible. The lesion in this case might, therefore, be designated as secondary or acquired buphthalmos in contradistinction to the classic primary type which is due to congenital defect of the structures about the filtration angle.

*Pulsation of the Globe and Bony Changes.*—Pulsation of the globe frequently accompanies neurofibromatosis of the orbit. It is not expansile in type, nor is there a bruit such as is noted at times in arteriovenous

16. Sachs'alber: Beitr. z. prakt. Augenh. **27**:1, 1897.

16a. Wiener, A.: Arch. Ophth. **54**:481 (Sept.) 1925.

17. Verhoeff, F. H.: Tr. Ophth. Soc. U. Kingdom **23**:176, 1903.

aneurysm. The pulsation is synchronous with the radial pulse. It arises from some defect in the orbital wall, according to Wheeler<sup>18</sup> and others, which permits a direct transmission of the pulsation from the brain to the tissues within the orbit. Foster Moore<sup>19</sup> reported 4 cases, and Rockliffe and Parsons<sup>20</sup> directed attention to the pulsation in a case they reported in 1904. The pulsation was not present in Wheeler's case. Its absence was explained by the small size and position of the defect which he found in the roof of the orbit and also by the fact that the buphthalmic globe was soft. There was no defect in the bony orbit and no pulsation of the globe in the case herein reported. The absence of a bony defect might be attributed to the fact that the plexiform changes in the nerves of the orbit were not advanced.

The exact cause of the bony defect in the orbit has not been determined. It may presumably arise from pressure erosion. LeWald<sup>21</sup> described "congenital absence" of the roof of the orbit in a paper on this subject.

Neurofibromatosis of the nerves of the periosteum with subsequent erosion and invasion of the bony walls of the orbit may occur in these cases.

Involvement of the other bones of the skeleton, particularly the spine, frequently accompanies Recklinghausen's disease. This was found in another case of glioma of the optic nerve which I have previously reported. The patient, a boy 6 years of age, had a congenital absence of part of the fibula and marked scoliosis, with pigmented spots in the skin. Brooks and Lehmann,<sup>22</sup> Lehmann,<sup>23</sup> Copeland, Craver and Reese<sup>24</sup> and others have directed attention to these changes. These authors attribute some of the bony changes, particularly those in the spine, to erosion and invasion of the bone from neurofibromatosis, which frequently involves the roots of the spinal nerves in this disease.

The exact nature of the osseous lesions in Recklinghausen's disease must await more extensive histologic study of the tissues involved.

*Changes in the Optic Nerve.*—Reese, Fisher and Foster Moore have directed attention to the presence of medullated nerve fibers in some of

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18. Wheeler, J. M.: Bull. Neurol. Inst. New York 5:476, 1936.

19. Moore, F.: Brit. J. Ophth. 15:272, 1931.

20. Rockliffe, W. C., and Parsons, J. H.: Tr. Path. Soc. London 55:27, 1904.

21. LeWald, L. T.: Am. J. Roentgenol. 30:756, 1933.

22. Brooks, B., and Lehmann, E. P.: Surg., Gynec. & Obst. 38:587, 1924.

23. Lehmann, E. P.: Recklinghausen's Neurofibromatosis and the Skeleton: Plea for Complete Study of the Disease, Arch. Dermat. & Syph. 14:178 (Aug.) 1926.

24. Copeland, M. M.; Craver, L. F., and Reese, A. B.: Neurofibromatosis with Ocular Changes and Involvement of the Thoracic Spine: Report of a Case, Arch. Surg. 29:108 (July) 1934.

the cases of neurofibromatosis. No definite explanation has been offered for this, and some regard their presence as accidental. It may be in some way related to excessive growth of the oligodendroglia of the nerve, particularly if, as Hortega<sup>25</sup> maintained, these cells are concerned with the elaboration or maintenance of the myelin sheaths of the nerves. According to Cone and McMillan,<sup>26</sup> these cells have not been demonstrated in the nonmyelinated portion of the optic nerve, though they are

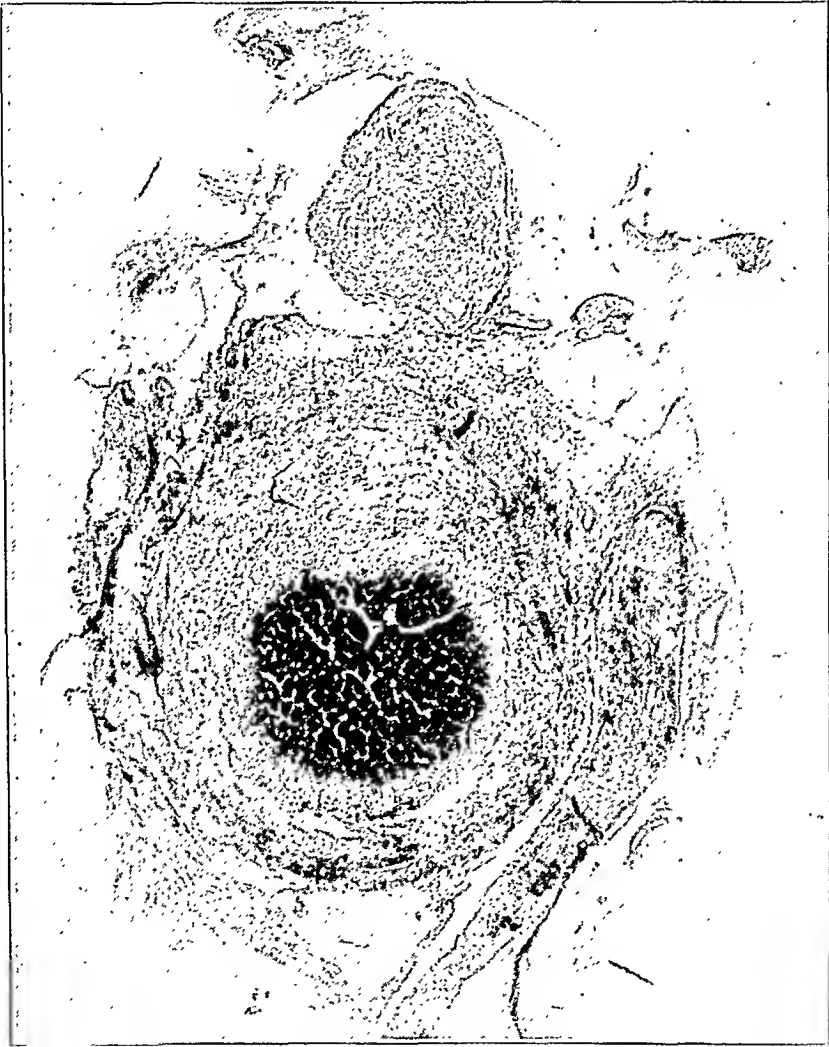


Fig. 24.—Ciliary ganglion (upper part of figure), glioma of the optic nerve, invading sheath (center) and enlarged ciliary nerve (right side).

normally present in animals, such as the rabbit, in which myelinated nerve fibers extended beyond the lamina cribosa into the retina.

*Tumors of the Optic Nerve and Central Lesions Involving the Brain and Cord.*—The association of tumors of the optic nerve and Reckling-

25. del Rio Hortega, P.: Tercera apartacion al conocieminta morfológico e interpretacion funcional de la ologodendroglia, 1928.

26. Cone and McMillan, in Penfield,<sup>4</sup> vol. 2, p. 837.

hausen's disease has been noted by a number of authors. Emanuel was among the first to direct attention to this, but the theory he evolved has never gained wide endorsement. In a recent paper on this subject by me,<sup>27</sup> based on a study of 5 cases and a review of the literature, the conclusion was reached that so-called primary tumors of the optic nerve are in many instances but a part of this syndrome.

Typical tumors of the optic nerve, however, have not been previously reported in association with plexiform neurofibromatosis of the lid or orbit. Collins stated that the optic nerve is liable to diffuse overgrowth of the fibrous elements in cases of plexiform neurofibromatosis, though he did not cite the presence of actual tumors in these cases. Reese referred to the changes in the optic nerve in Wheeler's case as "neurofibromatosis."

The tumor of the optic nerve in the case herein reported was a glioma, as were the 4 other cases referred to.

Tumors of the central nervous system, such as gliomas of the brain and spinal cord, as well as meningeal tumors, not infrequently accompany Recklinghausen's disease. A number of examples are reported in the literature. This association is a well recognized fact, but no satisfactory explanation has as yet been advanced to account for it. This subject is discussed more fully in my other paper,<sup>27</sup> which deals with other aspects of this case.

#### SUMMARY

The case here reported was one of plexiform neurofibromatosis of the orbit and globe, with slight enlargement of the eye. The lesion involved most of the nerves of the orbit and also those of the sclera, choroid, ciliary body and iris. There was an associated glioma of the optic nerve as well as central changes, which included gliomatosis of the intracranial portion of both optic nerves, the chiasm, thalamus, medulla and pons, and a glioma of the temporal lobe of the brain. Peripheral lesions, aside from those found in the eye and orbit, were limited to a few cutaneous café au lait pigmented patches which were distributed over the trunk and extremities. Similar pigmentary changes in the skin were found in the mother of the patient.

#### DISCUSSION

DR. F. H. VERHOEFF, Boston: From any point of view this is a beautifully worked-up case. This seems to be the only case of a glioma of the optic nerve associated with intraocular plexiform neuroma. At the time I reported my study of gliomas of the optic nerve there had been reported so few cases associated with plexiform neuroma that I thought this association might simply be coincidental. But the fact that Dr. Davis has reported 5 consecutive cases of the kind proves almost

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27. Davis, cited in footnote.<sup>3</sup>

conclusively that the two kinds of tumors are dependent on a common cause. If it should turn out that the peculiar tissue characteristic of plexiform neuroma is epiblastic in origin, the relation between the tumors in question would be more easily understood.

I concur with Dr. Davis in his explanation of the buphthalmos in his case. In 1903 I happened to be in London and attended the meeting at which Collins described a case of plexiform neuroma associated with buphthalmos. Collins attributed the glaucoma to a congenital anomaly of the filtration angle. I disagreed with this explanation and advanced another, which I now believe also to be incorrect. I then briefly described a case of buphthalmos in which the anterior ciliary nerves were neurofibromatous and produced a clinical picture as if there were numerous worms beneath the conjunctiva which were attached to the sclera near the cornea. I have never seen or heard of such a case since.



# SLIT LAMP OBSERVATIONS DURING EXPERIMENTAL INTRACAPSULAR EXTRACTION OF CATARACT

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NEW YORK

The main purpose of the experimental studies described here was to observe the physiodynamics of the intracapsular extraction of cataract and the effects on the anatomic structures in the anterior segment of the eye during the course of this procedure. This is the first experiment of its kind performed on the human eye. With this information made available, one can attempt to correlate with it the usual complications which arise instead of depending on the conjectural explanations so frequently offered.

With the aspiration method, 18 intracapsular extractions were performed on eyes enucleated from cadavers four to six hours after death. The youngest person was 40 years of age and the oldest 68. The details of the extractions were viewed through the slit lamp from various aspects on differently prepared specimens.

This paper will cover a brief description of the zonular apparatus and the anterior surface of the vitreous and the relation of the lens to these structures in the normal eye, followed by more elaborate studies of these structures in eyes undergoing intracapsular extraction. Since these structures and their relation are fairly constant in the normal eyeball, a proper understanding of them will enable the surgeon to appreciate more fully the actual changes which occur during an intracapsular extraction.

The following descriptions of slit lamp observations embrace the normal anatomic structure and the relation of the lens, zonule and vitreous (anterior surface).

## ANATOMIC STRUCTURE AND RELATION OF LENS, ZONULE AND VITREOUS (ANTERIOR SURFACE)

*Suspensory Ligament.*—Posterior Surface: Looking from above downward, one can see the irregular line of the ora serrata and then the much darker zone of the orbiculus ciliaris, from whence arise by one or two elevations the ciliary processes, with their small ridges and

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From the Department of Ophthalmology, the Mount Sinai Hospital.

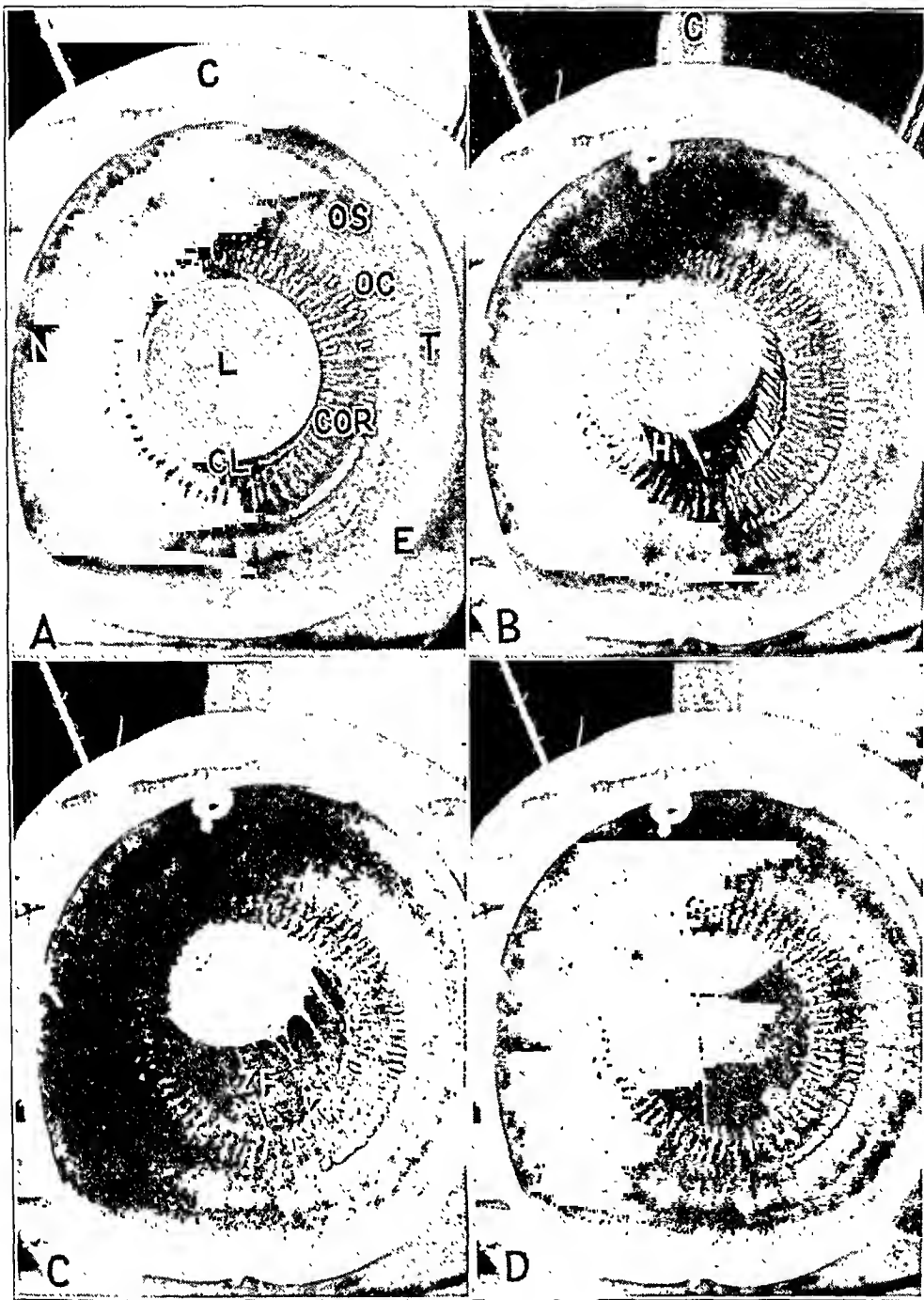


Fig. 1.—Successive steps of an experimental intracapsular cataract extraction by aspiration (posterior view). The vitreous, cornea and iris were removed. The fine details as observed through the microscope of a slit lamp (described under sections A, B, C and D) are not clearly defined in these photographs because of low magnification, fineness and transparency of the structure and poor stereopsis. The pictures are enlargements of prints taken with a Leica camera. In A, N indicates the nasal side; T, the temporal side; C, the cork rim; E, the equator; OS, the ora serrata; OC, the orbiculus ciliaris; COR, the corona ciliaris; CL, the circumlental space occupied by the anterior and posterior zonular membranes, and L, the posterior surface of the lens. In B, C is the glass cannula applied to the anterior lens capsule. There is traction on the lateral zonular fibers and ciliary processes. The ciliary processes superiorly are pulled forward and upward. H indicates a hole in the zonular membranes. In C, ZF indicates intact inferior zonular fibers with adhering agglutinated substance. Temporal ciliary valleys are occupied by retracted zonular membranes. In D the superior and superolateral ciliary processes demonstrate definite strain with resulting distortion.

their valleys concentrically fixed about the lens and, finally, the posterior surface of the lens (fig. 1 *A*). The equator of the lens is separated from the base of the processes by 1 mm. This space is filled with the free portion of the zonule.

The first structure that is seen from the posterior aspect of the suspensory ligament is a fine translucent pellicle which covers the ciliary region of the retina from just in front of the ora serrata up to the free portion of the processes. This membrane consists of a system of small cords seen as fine refractile bands, especially opposite the ciliary elevations (fig. 2). These are the posterior zonular fibers; several groups of these fibers appear to go toward the anterior depths of the valleys. A unifying translucent substance transforms the small zonular cords into a continuous membrane, which is extremely thin except in the portions reenforced by the zonular fibers.<sup>1</sup> This membrane is found in all the eyes examined by means of the higher powered slit lamp, which convinces one beyond doubt of the existence of an agglutinated substance. This substance, furthermore, shows no perforations. Topolanski<sup>2</sup> and others denied the existence of such a membrane. Unfortunately, they did not have a slit lamp available to make this observation.

**Anterior Surface:** One notices first of all that the lateral walls of the anterior two thirds of the base of the processes are almost rectilinear in the direction from behind forward. Here again one encounters a fine small membrane analogous to the one described posteriorly (fig. 3 *A*). Several spaces were found in the membrane between the anterior zonular fibers, signifying a deficiency of the intervening agglutinated substance. The small anterior zonular membrane joins the posterior zonular membrane at the level of the base of the processes and penetrates with it into the posterior part of the ciliary valley.

*Relation of the Zonular Fibers to the Ciliary Processes.*—The zonule, while capping intimately the posterior third of the ciliary process, is partially isolated from it. The attachment to the ciliary pigment cells underneath consists primarily of fine supporting fibers, and it is possible to detach the zonular layer in its entirety without carrying away the pigmented cells.

*Relation Between Zonule and the Hyaloid Membrane.*—According to Berger,<sup>3</sup> the internal layer of the zonule of Zinn is not adherent to the hyaloid membrane. There are, however, certain relations between these

1. Beáuvieux: La zonule (étude topographique et histologique), Arch. d'opht. 34:410 and 484, 1922.

2. Topolanski: Ueber den Bau der Zonula und Umgebung, nebst Bemerkungen über das albinotische Auge, Arch. f. Ophth. 56:419, 1903.

3. Berger, E.: Beiträge zur Anatomie der Zonula Zinnii, Arch. f. Ophth. 28:28, 1882.

two membranes which cannot be neglected. One finds that the hyaloid membrane, after carpeting the posterior lens capsule, applies itself against the layer of the posterior zonular fibers in order to elevate itself to the level of the processes. The approximation of these two flat surfaces necessarily creates a negative pressure, and if separation is attempted a resistance is encountered.<sup>4</sup> By the intermediary action of the zonule, the hyaloid membrane enters into contact with the ciliary crests, from which certain fibers separate it. They pass as a bridge over the valley.

*Attachment of the Zonular Fibers to the Lens.*—Within the equatorial, preequatorial and retroequatorial regions of the lens there is

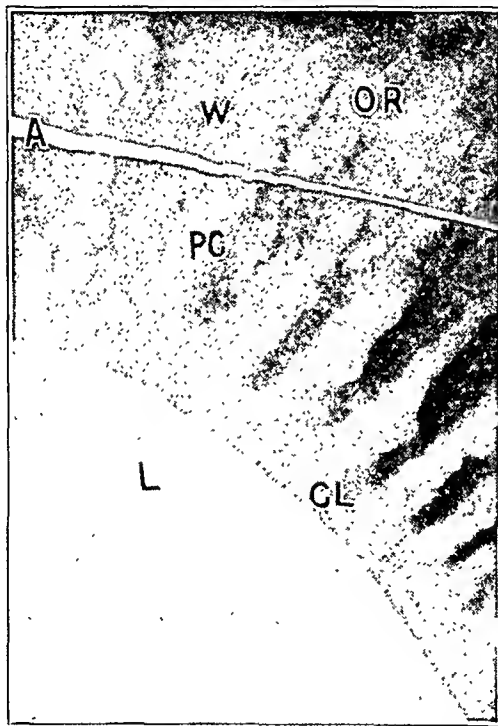


Fig. 2.—A sector taken from figure 1A demonstrating details of the inner surface of the anterior ciliary body, the circumlental space and the lens. *OR* indicates the orbiculus ciliaris; *PC*, the ciliary processes; *W*, small warts between; *CL*, the circumlental space occupied by zonular membranes (anterior and posterior); *L*, the lens, and *A*, an artefact.

an external layer of moderate thickness which is formed by the zonular fibers. These fibers dissociate themselves into their constituent elements at different levels along the path of insertion onto the lens. This layer is the much disputed "zonula lamella of Berger." These zonular fibers attach themselves to the underlying thin pericapsular membrane of Berger, which surrounds the entire outer surface of the capsule.

4. Csillag, F.: Dynamische Faktoren bei den intrakapsulären Starextraktion (nach Experimenten), *Ztschr. f. Augenh.* **91**:158, 1937.

*Anterior Surface of the Vitreous.*—The vitreous is fixed most firmly at the ora serrata to the ciliary epithelium in a zone some 1.5 mm. broad immediately adjacent to the ora serrata. This zone is called the base

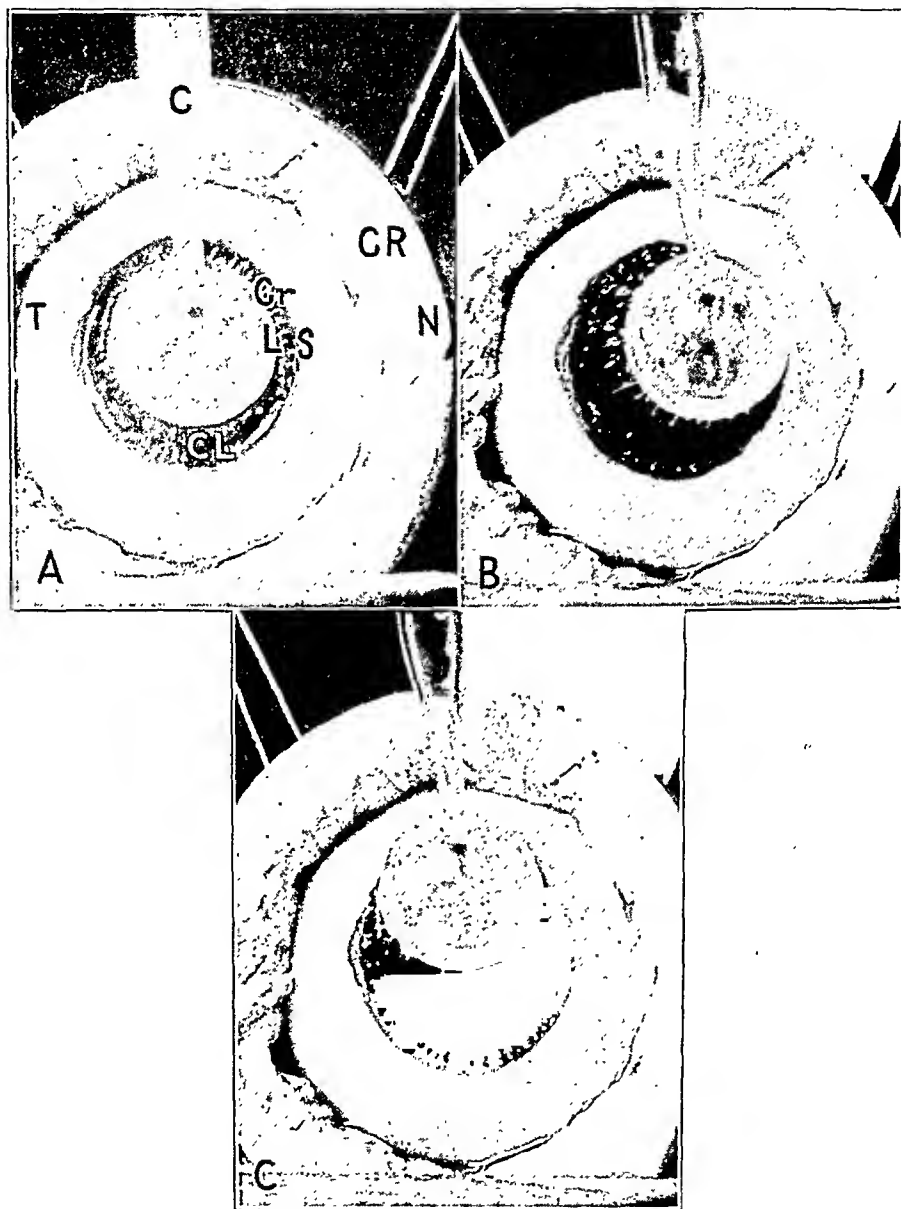


Fig. 3.—Successive steps of an experimental intracapsular extraction by aspiration (anterior view). The vitreous, cornea and iris were removed. In *A*, *N* indicates the nasal side; *T*, the temporal side; *C*, the cannula, *CR*, the cork rim; *S*, the cut edge of the sclera; *Cr*, the ciliary ridge; *CL*, the circumlental space occupied by the zonular membranes; and *L*, the anterior surface of the lens. *B* and *C* demonstrate stretching and rupturing of individual zonular fibers. Many holes are visible. The ciliary ridges superiorly project forward and upward.

of the vitreous, and its significance other than purely anatomic is important. In front of this region the vitreous is united to the inner surface of the ciliary body directly only here and there by delicate processes and mediately by zonular fibers.

Where the vitreous adjoins the lens a firmer union is again present in the form of a ring, 8 or 9 mm. in diameter, which is concentric with the border of the lens. Here lies the ligamentum hyaloideo-capsulare described by Wieger.<sup>5</sup> Both Wieger and Salzmann<sup>6</sup> have demonstrated this clearly. That region of the anterior surface of the vitreous (fossa patellaris) which lies within this ring comes in close contact with the posterior surface of the lens; at times a number of fine fibrils are found between the two surfaces when the lens is removed.

About the middle of the orbiculus ciliaris a thickening of the external framework of the vitreous again appears. This often begins with a fairly sharp border and stretches out over the whole of the anterior surface of the vitreous. It separates the vitreous from the posterior chamber and the lens and is therefore called the anterior border layer. This border layer consists of a large number of gossamer superficial parallel lamellae. The layer, also called by many the hyaloid membrane, is thin and transparent and remains unchanged up to the border of the lens. In the middle of the patellar fossa it becomes extremely thin.

Two other important systems of vitreous extensions are: (a) the free end of the central canal of Stilling,<sup>7</sup> which narrows to a point and usually strikes the lens nasal to its posterior pole, and (b) the ligamentes cordiformes, described by Campos.<sup>8</sup> These are winglike processes directed meridionally, dividing into fine fibrils which end at the membrana limitans interna ciliaris.

Comberg<sup>9</sup> and Duke-Elder<sup>10</sup> claimed that the vitreous is a true gel without any microscopic structure in the usual sense of the term and that the so-called hyaloid membrane is merely a condensation product. But since the majority of investigators have supported the existence of a definite membrane (hyaloid), one must necessarily base one's findings on this anatomic arrangement.

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5. Wieger, G.: Ueber den Canalis Petiti und ein "Ligamentum hyaloideo-capsulare," Inaug. Dissert., Strassburg, J. H. E. Heitz, 1883.

6. Salzmann, M.: The Anatomy and Histology of the Human Eyeball in the Normal State: Its Development and Senescence, translated by E. V. L. Brown, Chicago, University of Chicago Press, 1912.

7. Stilling, J.: Zur Theorie des Glaucoms, Arch. f. Ophth. (pt. 3) 14:259, 1868.

8. Campos: La portion reflexie de la membrane hyaloide, Arch. d'ophth. 18:748, 1898.

9. Comberg, W.: Beobachtungen am Glaskörper, Klin. Monatsbl. f. Augenh. 72:692, 1924.

10. Duke-Elder, W. S.: The Vitreous Humor, Tr. Ophth. Soc. U. Kingdom 49:83, 1929.

## EXPERIMENTAL STUDIES

Since the Barraquer suction apparatus was costly and the following studies were experimental, ordinary water suction was used. One end of a thick rubber tubing was placed over the vacuum outlet and the other end connected to a glass-constructed cannula which had approximately the same measurements as the Barraquer instrument (fig. 4). To maintain stability of the prepared enucleated eyeball during the experiments, it was necessary to make the following device: From a circular piece of cork 32 mm. in diameter and 5 mm. in thickness, a central piece 28 mm. in diameter was removed, leaving a rim of cork. The eyeball was sutured to this rim by means of the four rectus muscles. It was then placed

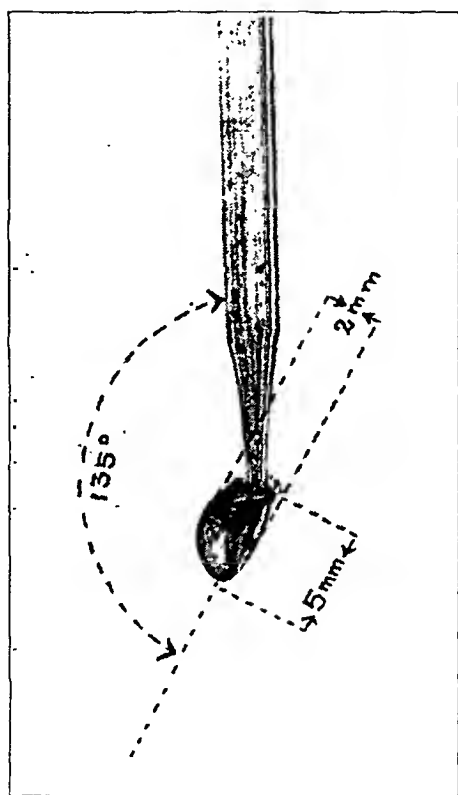


Fig. 4.—A modified Barraquer's glass cannula. (Constructed by Mr. H. O. Morgan, of Eimer and Amend, New York.)

in the prepared groove (5 mm. in width) of a cork base which had been attached securely to the chin rest of a slit lamp.

All of the following experimental intracapsular extractions were observed through the slit lamp after the prepared eyeballs were attached in the manner described. By means of this procedure the mechanical details of the operation and the effects on the anatomic structures in the anterior segment were viewed. A modified Barraquer's technic without tumbling of the lens was employed for all of the extractions.

The descriptions to follow will be divided into four sections, each section embracing a different view. The photographs in figures 1, 3, 5 and 6 demonstrate the successive steps of an intracapsular extraction from various aspects. Owing

to photographic difficulties and poor stereopsis, it was impossible to illustrate clearly the many fine detailed changes which occurred during the procedure.

For convenience, the anterior and posterior zonular fibers will be used interchangeably with the anterior and posterior zonular membranes, respectively, since the membranes are made up of zonular fibers and the intimately related agglutinated substance.

SECTION A.—*Posterior View with Vitreous Removed.*—A freshly enucleated eyeball was prepared by sectioning it through the equator. The entire vitreous body was removed, and a moderate degree of resistance was encountered at two places, namely: (a) the base of the vitreous and (b) the posterior lens capsule. The cornea and iris were removed, and the anterior segment was mounted as previously described, so that the posterior view of the anterior segment was visible (fig. 1).

The cannula was placed a little above the center of the anterior lens capsule and suction applied. The traction was increased by drawing the lens forward and upward with side to side movements, placing the anterior and posterior zonular fibers from 4 to 8 o'clock under slight tension. The ciliary processes from 10 to 2 o'clock, which were straddled by the zonular membranes, shifted with the immediately adjacent structures forward and sideways with each horizontal excursion of the cannula. Below, the ciliary processes and the adjacent anterior orbiculus ciliaris for an approximate distance of 1 mm. were pulled forward and upward.

When the traction on the lens was released, the ciliary processes resumed their former shapes, and several rents were seen in the zonular membrane at 11, 12 and 1 o'clock. These rents represented the ruptured zonular fibers and tears in the surrounding agglutinated substance. When greater traction was resumed, the foregoing picture was reproduced, but with more evident pull on all the structures concerned. The fibers below were stretched almost 2 mm. before they commenced to rupture. While the lens was midway in delivery, the inferior and inferolateral zonular fibers were stretched to their maximum in a straight line, and the breaking occurred nearer to its ciliary attachment. This was followed later by transferring the traction pull to the remaining superior and superolateral fibers, which eventually also broke closer to the ciliary anchorage bed.

From the foregoing description, it can be seen that the majority of the zonular fibers invariably ruptured closer to the ciliary attachment. They broke gradually but constantly from the beginning to the end of the extraction. As soon as the fibers broke there was a quick recoil of the ruptured ends in opposite directions (comparable to the severing of a stretched elastic). One end was pulled toward the posterior ciliary valley and the other end onto the lens proper in the region of its attachment.



When the lens was completely delivered, the tugged and tensed structures resumed their former shapes and positions, with the exception of the superior half of the circumference. Here the moderately curved ciliary processes and the corresponding adjacent orbiculus ciliaris were drawn slightly forward from the underlying sclera. By teasing the surfaces of the ciliary valleys, the lateral borders of the ciliary processes, the anterior orbiculus ciliaris and the preequatorial and retroequatorial regions of the lens with a fine needle, the severed zonular fibers and remnants of the agglutinated substance could be picked up and demonstrated easily.

SECTION B.—*Anterior View with Vitreous Removed.*—The eyeball was prepared exactly as under section A and mounted so that the anterior view was available for study. The demonstration of the anterior bases of the superior and superolateral ciliary processes being pulled forward and straddled by the tense zonular membranes was unusually interesting from this view. The inferior zonular fibers were drawn obliquely upward and forward.

The iris root plus the ciliary ridges and valleys acted as a resistance bar over which the superior curved zonular fibers were made to pass. This resisting body added materially to the marked traction pull and thus permitted the transmission of increased energy posteriorly along the inner surface of the ciliary body. The inferior and inferolateral zonular fibers always transferred their maximal tension along a straight line.

This view was presented primarily to supplement the posterior view as described in the previous section.

SECTION C.—*Posterior View with Hyaloid Membrane Intact.*—The structures in the anterior segment appeared smaller and distorted after the vitreous body had been sectioned through the equator. This followed, since the posterior portion of the remaining anterior surface of the vitreous formed an irregular concavity which acted as a myopic cylindric lens (fig. 5).

The lens and a corresponding area in the hyaloid membrane were drawn forward after the cannula had been applied. The surrounding hyaloid membrane followed more slowly. In the retroequatorial region of the lens a grayish black concentric ring was noted. This corresponded to the outermost circle of contact which existed between the hyaloid membrane and the posterior lens capsule and also included the attachment of the ligamentum hyaloideocapsulare. The posterior zonular fibers were seen through the hyaloid membrane, and evidence of their stretching was noted inferiorly. Superiorly, the hyaloid membrane behind the ciliary processes was placed under greater tension with the rising lens. This was indicated in the following ways: 1. The hyaloid membrane

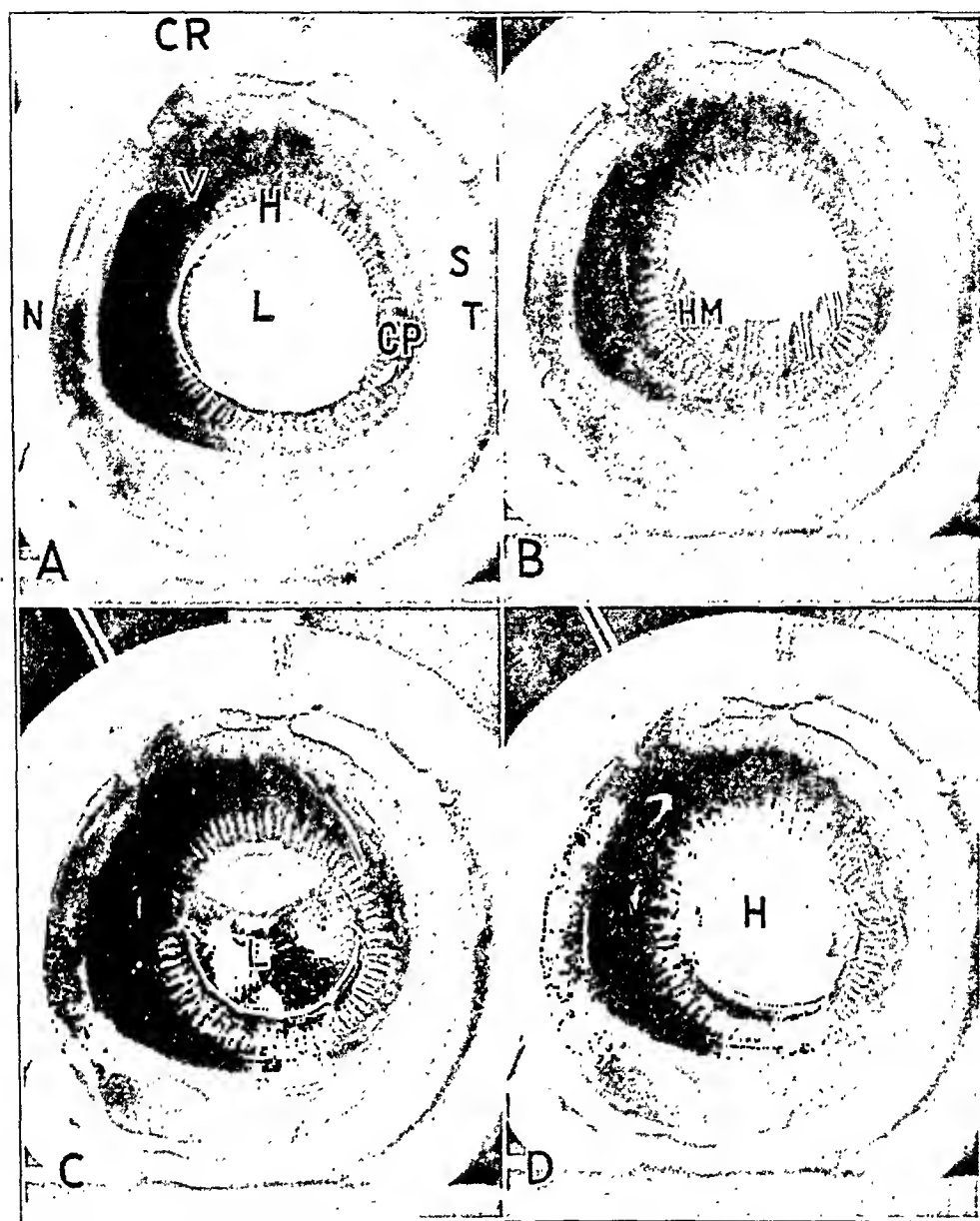


Fig. 5.—Successive steps of an experimental intracapsular extraction by aspiration with the anterior surface of the vitreous intact (posterior view). The cornea and iris were removed. In *A*, *N* indicates the nasal side; *T*, the temporal side; *CR*, the cork rim; *S*, the cut edge of the sclera; *V*, the anterior surface of the vitreous; *CP*, the ciliary processes; *H*, a highlight, and *L*, the posterior surface of the lens. In *B* the ciliary processes and the hyaloid membrane (*HM*) superiorly are lifted upward and forward. The membrane above is indented between the rising lens and the ciliary ridge. The zonular fibers are rupturing below. In *C* many inferior zonular fibers are ruptured. With gradual separation of the lens, the traction on the superior ciliary processes and the hyaloid membrane diminishes. The hyaloid membrane is seen clearly with its irregular, grayish condensed lamellae (*L*). In *D* the lens has been delivered. *H*, indicates a large highlight on the hyaloid membrane. The superior ciliary ridges point forward and upward.

wedged itself slightly in between the ciliary fissures without going to their depths. 2. An indentation of the membrane was present between the ciliary ridges and the rising portion of the membrane which was attached to the posterior lens capsule. The tension which resulted from the increased stretching of the hyaloid membrane and zonular fibers was transmitted backward along the inner surface of the ciliary body and infrequently in the neighborhood of the base of the vitreous.

The aforementioned traction was usually sufficient to cause a partial detachment of the ciliary body in the majority of experiments (see section A) and an occasional tearing away of the hyaloid membrane at the base of the vitreous. In order to appreciate this change, it must be remembered that the outer surfaces of the ciliary body and the anterior choroid are loosely attached to the sclera by delicately long, thin supra-choroidal lamellae. Consequently, in these areas direct attachment of the ciliary body and the choroid to the sclera is almost negligible.<sup>11</sup> Since the majority of the zonular fibers arise from almost the entire surface of the orbiculus ciliaris, any moderate degree of traction on it should be sufficient to detach the ciliary body and the anterior surface of the choroid from the sclera. This picture was duplicated in the majority of the extractions performed in these experiments (see also section A).

When the extraction was three-quarters through, the superior indentation and the impressions of the ciliary fissures in the hyaloid membrane became less and less accentuated. This occurred because of the gradual separation and retraction of the membrane from the posterior lens capsule from above downward. At this stage all of the zonular fibers inferiorly had ruptured.

The hyaloid membrane occupied the space immediately behind the iris after it had separated completely from the posterior lens capsule and all of the zonular fibers had been torn.

SECTION D.—*Anterior View with Vitreous Intact.*—During the extraction of the lens an added resistance could be felt other than that offered by the anterior and posterior zonular fibers (fig. 6). As the hyaloid membrane was hidden by the presenting lens, one was obliged to study it inferiorly only after several holes had formed in the anterior and posterior zonular membranes. Strictly speaking, there is no cavity or small linear space between the hyaloid membrane on one side and the posterior zonular membrane and the posterior lens capsule on the other side.

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11. O'Brien, C. S.: Detachment of the Choroid After Cataract Extraction: Clinical and Experimental Studies, with Report of Seventy-Five Cases, *Arch. Ophth.* 14:527 (Oct.) 1935. Salzmann.<sup>6</sup>

It was observed that the hyaloid membrane separated from the posterior zonular membrane with a greater facility than it did from the posterior lens capsule. This gradual separation always occurred along a plane tangential to the lens. With a sharply focused slit beam, one could see from a lateral view the rupturing of fine fibers along the path of dislocation. These fine fibers may be anatomic connections which normally are found between the posterior lens capsule and the hyaloid membrane, or they may have resulted from senile degenerative changes or chronic low grade inflammation.

The following experiment was performed to furnish further proof of a definite resistance offered by the hyaloid membrane: The anterior and posterior zonular membranes were cut through concentrically without disturbing the lens from its patellar fossa, and an attempt was made to remove the lens by drawing it directly forward in the axis of the eyeball. A decided resistance was felt, even though the lens had its zonular fibers attached. On removal of the lens in this manner, the separation occurred slowly. The patellar fossa which was concave now became convex (herniation), and in this way the separation of the hyaloid membrane occurred concentrically from the equator of the lens.

With the extraction of the lens complete, the hyaloid membrane became entirely visible. A large depression was noted which corresponded to the patellar fossa. In several experiments a herniation of the membrane was found instead of the usual depression. There was a circular grayish band within the depression which corresponded to the ligamentum hyaloideocapsulare. The hyaloid membrane was thin and transparent and offered an elastic resistance to an applied force. It tore easily when punctured, and the edges of the wound gapped because of the inherent retractility of the membrane.<sup>12</sup>

In the majority of experiments the rim of the hyaloid membrane adjacent to the fossa occupied the space immediately behind the iris, but infrequently the membrane temporally and suprotemporally was either in the plane of the base of the vitreous or in the zonular cleft. Here a detached arc with some pigment spots was visible, and it appeared as though it arose from a region within the base of the vitreous, since each extremity of the arc was lost in the general direction of the ora serrata. Several stretched silvery strands, which were fine and long, seemed to join this detached arc to the region it formerly occupied. These strands should not be mistaken for the parallel meridional furrows of the hyaloid membrane which normally overlie the ciliary processes.

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12. Vannas, M.: Klinische und experimentelle Untersuchungen über die vorderen Teile des Glaskörpers, insbesondere nach intrakapsularen Linsenextraktionen, *Klin. Monatsbl. f. Augenh.* 89:318, 1932.

In all probability, one is here confronted with a peculiar affinity of the hyaloid membrane to the posterior lens capsule and the posterior zonular membrane. This is a factor of paramount importance in intracapsular

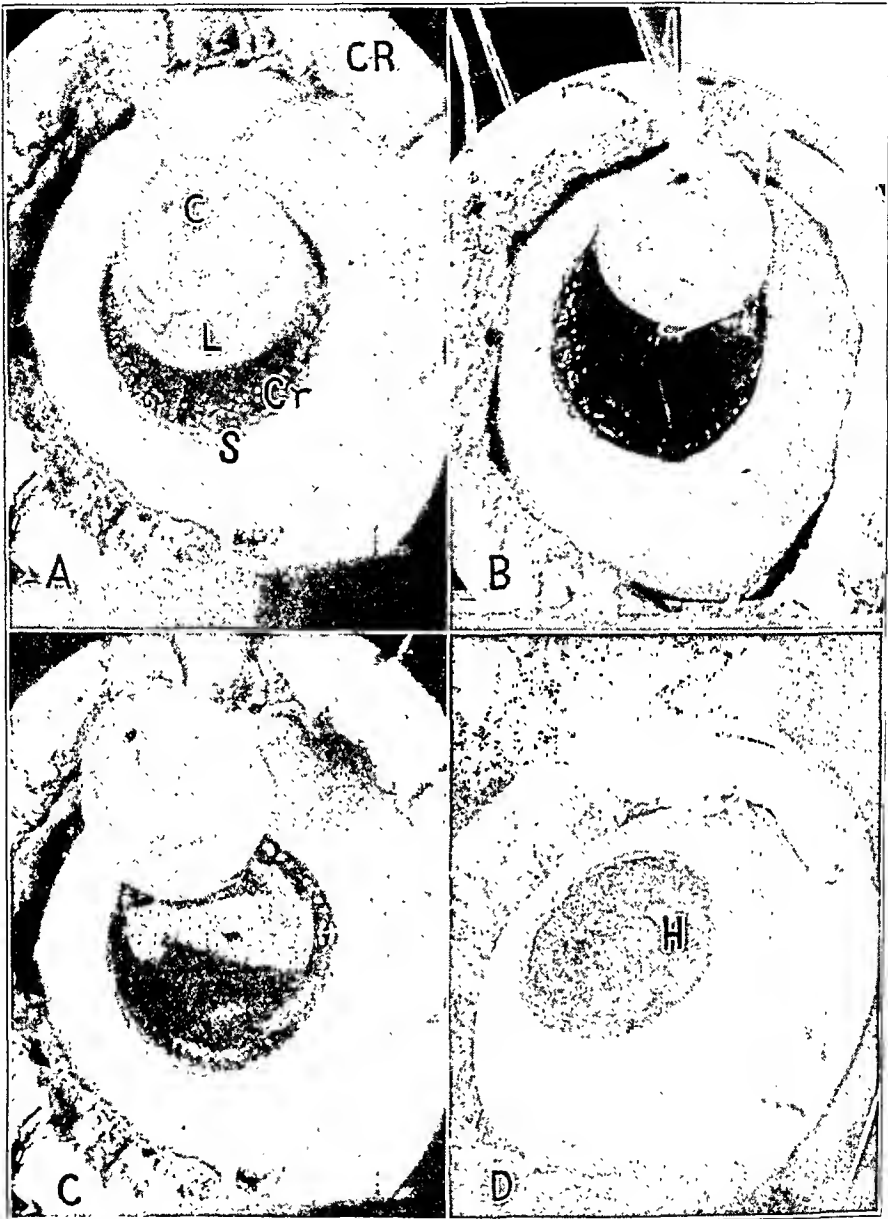


Fig. 6.—Successive steps of an experimental intracapsular extraction by aspiration (anterior view). The cornea and iris were the only structures removed. In *A*, *CR* indicates the cork rim; *S*, the cut edge of the sclera; *C*, the cannula; *Cr*, the ciliary ridges, and *L*, the anterior lens capsule. Stretching of the zonular membranes is demonstrated. In *B* many inferior zonular fibers have ruptured. In *C*, the hyaloid membrane is indented above but is still adherent to the inferior part of the posterior lens capsule. The ciliary ridges are projecting forward and upward. In *D* a highlight (*H*) is shown in the depth of the fossa patellaris. The lens has been delivered.

extraction. It cannot be disregarded because prolapse and loss of vitreous are of relatively high incidence in almost any series of cases.

#### COMMENT

The detailed descriptions of the four previous sections (A, B, C and D) combined into one picture give a fairly good conception of the general physiodynamics of an intracapsular extraction and its effects on the structures in the anterior segment of an eye. Since the parts in this region are so closely related anatomically, the experiments have borne out conclusively that the relatively great traction which is necessarily exerted on the zonular fibers during the dislocation and delivery of the lens must be transmitted to the inner surface of the ciliary body, the anterior surface of the choroid and the anterior surface of the vitreous. Therefore, one can understand how this manipulatory procedure can cause almost all of the complications which usually ensue either at the time of operation or postoperatively.

In reviewing the vast literature on intracapsular extraction, one is struck by the constant and identical sequelae which are reported in the majority of statistical studies. In a series of 500 successive cases in which intracapsular extraction was done, Knapp<sup>13</sup> reported that loss of vitreous occurred in 42. This was definitely greater than occurred in the cases in which extracapsular extraction was done. He stated that it was probably due to excessive traction and cautioned one not to minimize this complication. Kubik,<sup>14</sup> of the Elschmig clinic, after using the Stanculeanu-Török method in a series of 526 cases, concluded that regardless of the type of operation resorted to, the loss of vitreous was high. Dunphy,<sup>15</sup> after surveying 2,500 cases at the Massachusetts Eye and Ear Infirmary in 1927, was also of the opinion that loss of vitreous occurred more frequently at intracapsular extraction.

Experimentally, Csillag<sup>4</sup> performed a number of intracapsular extractions on pigs' eyes and observed that the lamellae of the hyaloid membrane separated with moderate difficulty from the posterior lens capsule. The adhesive force between the posterior lens capsule and the hyaloid membrane was unusually strong in the pig's eye. A similar adhesion was found to exist in the human eye, but to a lesser degree. The experiments in sections C and D prove that such a force exists between the lens and the hyaloid membrane normally.

13. Knapp, A.: Complications of Forceps Intracapsular Operation for Cataract Based on an Analysis of Five Hundred Successive Cases, *Arch. Ophth.* **16**:770 (Nov.) 1936.

14. Kubik, J.: Ueber Altersstarextraktionen in der Kapsel, *Ber. ii. d. Versamml. d. deutsch. ophth. Gesellsch.* **46**:185, 1927.

15. Dunphy, E. B.: Loss of Vitreous in Cataract Extractions, *J. A. M. A.* **89**:2254 (Dec. 31) 1927.

In addition, another factor must be considered, because in several eyes pigment granules and minute adhesions were found on the hyaloid membrane behind the lens and the ciliary processes. It is possible that degenerative changes or long-continued low grade inflammations exist in these regions with the formation of pathologic products. Thus, in order to deliver the lens one must overcome the resistance offered by these minute organic connections plus the strong adhesion between the posterior lens capsule and the thin hyaloid membrane. It is therefore not uncommon to find tears in the hyaloid membrane in such eyes. A number of surgeons have even reported ruptures in the membrane after favorable operations.<sup>16</sup>

The separation of the hyaloid membrane from the inner surface of the ciliary body to which it is united directly only here and there by delicate processes and mediately by zonular fibers was shown in section D. It is not possible to observe this clinically because it is not within the range of visibility ophthalmoscopically. With the corneal incision healed and drainage reestablished in the anterior chamber, a partial readjustment of the detached hyaloid membrane to its former position over the ciliary processes most likely follows.

A case was recently reported by Bassin<sup>17</sup> of detachment of the vitreous in the area of the ora serrata (base of the vitreous) following intracapsular extraction. Slit lamp examination showed a whitish gray membrane with a thickened margin and folds running parallel to it. The membrane was in the frontal plane oscillating slightly on extreme motion of the eye. Bassin thought that the detachment of the vitreous was caused by the pressure on the eye and massage during the difficult delivery of the lens. These findings were confirmed by experimental observations in several experiments reported here (section D).

Retinal detachment may occur after the base of the vitreous has separated, since the vitreous takes part of the ciliary epithelium with it and the end of the retina loses its attachment. Bassin, however, did not observe retinal detachment in his case. There is another possible explanation for the causation of retinal detachment following intracapsular extraction. After the partial separation of the anterior surface of the vitreous from the inner surface of the ciliary body plus the great tendency of the vitreous to protrude into the anterior chamber after the loss of the capsulosuspensory diaphragm, it seems plausible that the constant surging of the vitreous back and forth may eventually

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16. Wright, R. E.: Barraquer Operation and Vitreous Changes, *Am. J. Ophth.* **7**:155, 1924.

17. Bassin, R.: Beitrag zur Frage der Glaskörperabhebungen, *Klin. Monatsbl. f. Augenh.* **97**:599, 1936.

lead to a detachment of the retina.<sup>18</sup> Arruga<sup>19</sup> expressed the belief that predisposition to retinal detachment occurs more frequently after intracapsular cataract extraction.

During an extraction a moderate degree of traction is exerted on the ciliary body and occasionally on the base of the vitreous, producing a low grade traumatic cyclitis which may manifest itself later by the formation of opacities of the vitreous.<sup>16</sup> These opacities may originate from two sources: (1) cellular infiltrations through the anterior hyaloid membrane from the underlying ciliary processes and (2) the ciliary epithelium which is firmly connected to the fibrils of the vitreous at the base. Experiments under sections A and C demonstrated this force, and it would not be improper to regard this traction as the possible causation of these opacities.

Prolapse of the iris is also a relatively frequent complication after intracapsular extraction. With the removal of the capsulosuspensory diaphragm, the vitreous pushes itself immediately behind the iris, filling the space formerly occupied by the lens. Since the corneal wound is an established area of lowered resistance in the early postoperative stage, the iris superiorly is gradually pushed forward by the hernial protrusion of the vitreous up to and at times through the incisional edges, with a resulting prolapse. It would seem, therefore, that the capsulosuspensory diaphragm has some place and function in the eye; if it is destroyed by operation, complications may follow immediately or at some later date.

O'Brien<sup>20</sup> examined a series of 50 patients postoperatively (from the first to the seventh day) and found flat choroidal detachments encircling the entire periphery in 33. The remaining patients exhibited partial separations. Another group of 92 patients were studied by O'Brien<sup>11</sup> during or immediately after operation, and 86 demonstrated choroidal detachments, an incidence of 93 per cent.

The great traction which is necessarily exerted on the ciliary body and the anterior surface of the choroid through the zonular fibers provides a reasonable explanation for the frequent detachment of these structures. These separations are greatly favored because of two important factors: (1) the weak connection of the ciliary body and the anterior surface of the choroid to the underlying sclera by infrequent and delicate suprachoroidal lamellae and (2) the decrease in intraocular tension immediately after the corneal section.

18. Peter, L.: Slitlamp Studies of Hernias of the Vitreous, *Am. J. Ophth.* 6:644, 1923.

19. Arruga, H.: *Detachment of the Retina*, translated by R. Castroviejo, New York, B. Westermann, 1936, p. 12.

20. O'Brien, C. S.: Further Observations on Detachment of the Choroid After Cataract Extraction, *Arch. Ophth.* 16:655 (Oct.) 1936.



Several surgeons<sup>21</sup> have expressed the belief that choroidal detachments occur only after the intraocular tension has been lowered, which results in transudation of serum from the relaxed choroidal blood vessels into the suprachoroidal space. But it would appear from the foregoing experiments that if transudation did take place, it would follow only after the ciliary body and the anterior surface of the choroid had been detached. Therefore, the transudate is not to be considered as the primary factor of the separation but merely a secondary manifestation. Whether or not these separations produce detrimental changes in the integrity of an eye cannot be answered at present.

#### SUMMARY AND CONCLUSION

Slit lamp studies of the anatomic relation of the zonule, ciliary body, lens and hyaloid membrane from fresh human eyes are described.

The following subjects were analyzed on the basis of slit lamp observations of a series of experimental intracapsular cataract extractions on fresh human material: (a) the nature of direct trauma to the ciliary epithelium, (b) detachment of the ciliary body and anterior surface of the choroid, (c) the process of rupture of the zonular fibers, (d) the tendency toward the production of tears in the hyaloid membrane and prolapse of the vitreous and (e) the predisposition to retinal detachment following occasional trauma to the base of the vitreous.

One should not minimize the traction force employed in intracapsular cataract extraction, since it is of paramount importance in explaining a number of the complications which arise either operatively or post-operatively.

An accurate method for determining the true state of contact existing between the opposing surfaces of the hyaloid membrane on one side and the posterior lens capsule and posterior zonular membrane on the other side would help the surgeon in choosing his operative material more carefully. It would probably decrease the comparatively high incidence of tears and prolapse of the vitreous.

A broader understanding of the essential features in the physico-dynamics would permit a more intelligent approach to the intracapsular extraction. Continuation of experimental work in this field is necessary, since not all of the important questions have been answered. Further refinements in the operative technic, with special attention directed to diminishing the intensity of traction, would probably make a difficult operation safer, so that the average ophthalmic surgeon could undertake it with greater confidence.

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21. Hagen, S.: Die seröse postoperative chorioidical Ablösung und ihre Pathogenese, *Klin. Monatsbl. f. Augenh.* 66:161, 1921. Fuchs, E.: Ablösung der Aderhaut nach Operation, *Arch. f. Ophth.* 53:375, 1901. O'Brien.<sup>20</sup>

# BILATERAL DETACHMENT OF THE RETINA

## A HEREDODEGENERATIVE DISEASE

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Since Gonin's operation for detachment of the retina, the prognosis of this disease has not been as desperate, yet it is still fairly serious. When patients are operated on without any consideration as to the favorableness of their condition, not more than 50 to 60 per cent recover. Thus those affected in both eyes are seriously endangered.

Binocular detachment may rarely have a secondary exudative or transudative cause, as in nephritis, especially in the young, in which case the prognosis for life is poor. It also occurs in the nephritis of pregnancy, in exudative retinitis and in proliferating retinosis occurring after hemorrhages into the vitreous.

Even allergy has been involved in the explanation of bilateral detachment, as in the case of Balyeat<sup>1</sup> and that of Prewitt.<sup>2</sup>

Primary "idiopathic" binocular detachment is more frequent. Here also are classified detachments following nonperforating injuries, since the participation of such an injury in the detachment, i. e., the relation of a predisposing cause and injury, is not yet cleared up. The proportion of patients with bilateral detachment among all patients with detachment according to several authors is as follows: Fodor,<sup>3</sup> 8 per cent; Bartels,<sup>4</sup> 9 per cent (of 186 patients); Jeandelize, Baudot and Gault,<sup>5</sup> 9.2 per cent (of 123 patients); Oradovskaya and co-workers,<sup>6</sup> 11

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From the Northwestern University Medical School, Chicago, and from the State Eye Hospital, Budapest, Hungary, Director, Prof. Josef Imre.

1. Balyeat, R.: Complete Retinal Detachment (Both Eyes), with Special Reference to Allergy as a Possible Primary Etiologic Factor, *Am. J. Ophth.* **20**:580, 1937.

2. Prewitt, L. H.: Retinal Detachment Due to Allergy: Report of a Case, *Arch. Ophth.* **18**:73 (July) 1937.

3. Fodor, G.: Gonin Operation in Surgical Therapy of the Detached Retina, *Orvosi hetil.* **77**:1111, 1933.

4. Bartels: Statistik der Fälle von Netzhautablösung, *Klin. Monatsbl. f. Augenh.* **96**:687, 1936.

5. Jeandelize, P.; Baudot, R., and Gault, A.: Résultat du traitement du décollement rétinien par la diathermo-coagulation: Statistique opératoire, *Bull. et mém. Soc. franç. d'ophth.* **49**:269, 1936.

6. Oradovskaya, E. I.; Przhibylskaya, Y. I., and Skorodinskaya, V. V.: Etiology and Prophylaxis of Detachment of the Retina, *Sovet. vestnik oftal.* **4**:388, 1934.

per cent (of 251 patients); Gonin,<sup>7</sup> 11.6 per cent; Arruga,<sup>8</sup> 17.7 per cent (of 682 patients); Dunnington and Macnie,<sup>9</sup> 17.8 per cent (of 314 patients); Maertens,<sup>10</sup> 20 per cent (of 229 patients); van Manen and Weve,<sup>11</sup> 22 per cent; Gifford,<sup>12</sup> 22.6 per cent, and Deutschmann,<sup>13</sup> 32 per cent. This last figure differs greatly from the others and may be explained by the fact that this author was consulted for his special operation by many patients who were in a hopeless condition, being blind in both eyes. The different proportions in the statistics may be explained by the different estimation of the condition of the first involved eye. The detachment in this eye may be hidden by complicated cataract, or the eye may even have been removed for painful secondary iridocyclitis. In addition, in some of the cases of unilateral detachment, detachment may develop later in the fellow eye. Taking this fact into consideration and subtracting such cases from the unilateral ones, in which the role of the injury was supposedly decisive, and subtracting also those of inflammatory origin, the proportion of cases of bilateral detachment among detachments of idiopathic origin may amount to 20 to 25 per cent.

In eight and one-half years, from January 1930 to June 30, 1938, there were 270 patients treated for retinal detachment in the State Eye Hospital in Budapest, Hungary. Only a few of them have not been subjected to operation. Thirty-three patients, or 12.2 per cent (as shown in the accompanying table), suffered with bilateral detachment; 23 were men (70 per cent) and 10 women.

#### SEX AND AGE

The percentage of men in the different statistics on unilateral and bilateral detachment is as follows: Sattler,<sup>14</sup> 65 per cent; Arruga,<sup>8</sup>

7. Gonin, in Lagrange, F., and Valude, E.: *Encyclopédie française d'ophtalmologie*, Paris, O. Doin, 1903-1910, vol. 6, p. 977.

8. Arruga, H.: *Etiología y patogenia del desprendimiento de la retina*, in Arruga, H.; Ovio, G., and Vogt, A.: *Temas oficiales (rapports) sobre el desprendimiento de la retina*, Madrid, 1933.

9. Dunnington, J. H., and Macnie, J. P.: Detachment of the Retina: Operative Results in One Hundred and Fifty Cases, *Arch. Ophth.* **13**:191 (Feb.) 1935; Detachment of the Retina: Operative Results in One Hundred and Sixty-Four Cases, *ibid.* **18**:532 (Oct.) 1937.

10. Maertens, H.: *Das andere Auge bei spontaner Ablatio*, Dissert., Köln, T. Borowsky, 1937.

11. (a) van Manen, J. G.: *Die diathermische Behandlung der Netzhautablösung in der Universitäts-Augenklinik in Utrecht*, Utrecht, 1936. (b) Weve, H. J. M., and van Manen, J. G.: *Technique et résultats du traitement diathermique du décollement de la rétine en 1935*, *Bull. et mém. Soc. franç. d'opht.* **49**:281, 1936.

12. Gifford, S. R.: *Surgical Treatment of Retinal Detachment*, *Arch. Ophth.* **16**:405 (Sept.) 1936.

13. Deutschmann, cited by Arruga.<sup>8</sup>

14. Sattler, cited by Arruga.<sup>8</sup>

59.5 per cent; Stallard,<sup>15</sup> 62 per cent; Bartels,<sup>4</sup> 68 per cent, Dunnington and Macnie,<sup>9</sup> 67 per cent. In the 270 cases from the State Eye Hospital men and women participate in about the same proportion, 132:138.

In this series detachment occurred in the first eye at an average age of 39 and in the fellow eye at the age of 44. In 23 patients the detachment developed within five years after that in the first eye. Figure 1 shows the distribution of patients with detachment according to age groups. The curve for the patients with bilateral detachment is irregular; there are two peaks in the third and in the sixth decade,

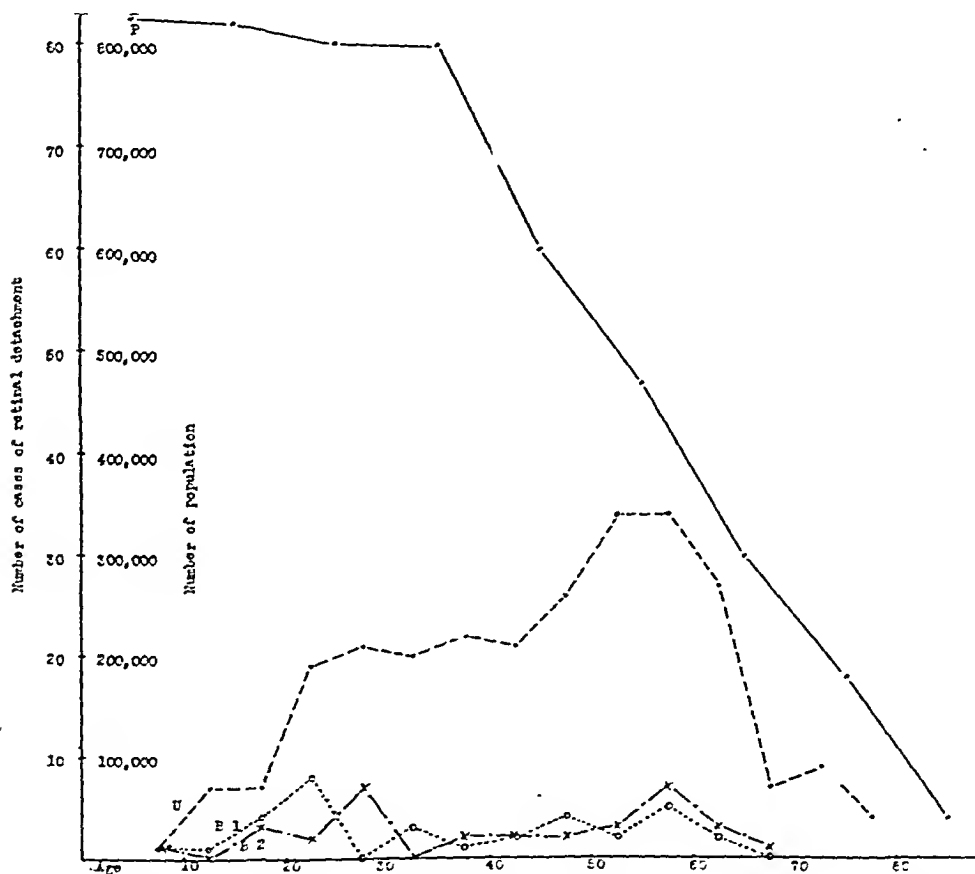


Fig. 1.—Curve *P* shows the distribution of the population of Hungary in 1936 according to age groups; *U*, the distribution of patients with unilateral detachment according to age groups; *B1*, the distribution of patients with bilateral detachment according to the age when the first eye became involved, and *B2*, the distribution of patients with bilateral detachment according to the age when the fellow eye became involved.

respectively. The curve for the patients with unilateral detachment shows one peak in the sixth decade. Maertens<sup>10</sup> found most cases of bilateral detachment in persons in the third decade. In such patients the degenerative process leading finally to the retinal hole is not con-

15. Stallard, H. B.: Some Observation on the Causes and Treatment of Simple Detachment of the Retina, *Brit. J. Ophth.* 14:1. 1930.

*Data on Thirty-Three Cases of Bilateral Detachment*

| Case No. | Sex | Age When Detachment Developed | Refraction                      | Injury   | Ocular Condition  | Number of Operations | Result †                      |
|----------|-----|-------------------------------|---------------------------------|--|---|----------------------|-------------------------------|
| 1        | M   | First eye L, 21               | Myopia 5.5 D.                   | .....  | Total detachment except a small upper portion; detachment obviously started temporally, since patient observed the contraction of field nasally | No operation         | 0                             |
|          |     | Second eye R, 30              | Myopia 5.0 D.                   | .....  | Temporally and out and above 5 round degenerative holes   | Two operations       | +                             |
| 2        | M   | First eye R, 19½              | Myopia 8 D.                     | .....  | Total detachment; hole not visible; cataract 7 yr. later  | No operation         | 0                             |
|          |     | Second eye L, 22½             | Myopia 8.0 D. C<br>—1.0 D. cyl. | .....  | No hole; subretinal strain  | .....                | Spontaneous recovery          |
| 3        | M   | First eye L, ?                | Myopia ?                        | .....  | No red reflex   | No operation         | 0                             |
|          |     | Second eye R, 9               | Myopia 10 D.                    | .....  | Large tear temporally from 7 to 10 o'clock  | One operation        | —                             |
| 4        | M   | First eye L, 50               | Myopia 4 D.                     | Cataract extraction 3 yr. before detachment was discovered | Total detachment; large folds in which a hole could be hidden   | No operation         | 0                             |
|          |     | Second eye R, 55              | Myopia 10 D.                    | .....  | Arched tear of 5 P. D. down and out   | Four operations      | ± Count fingers at 1.5 meters |
| 5        | F   | First eye R, 60               | High myopia                     | .....  | Iris bombeé; cataract   | No operation         | 0                             |
|          |     | Second eye L, 62              | Myopia 14 D.                    | .....  | Round hole of ½ P. D. at 6 o'clock  | Two operations       | —                             |
| 6        | M   | First eye R                   | ?                               | Stroke of lightning  | Seclusion and occlusion; cataract   | No operation         | 0                             |
|          |     | Second eye L                  | Emmetropia                      | Cataract extraction 2 yr. before detachment was discovered | Peripheral tear temporally from 2 to 4 o'clock  | Four operations      | —                             |
| 7        | M   | First eye R, 57               | Emmetropia (?)                  | .....  | Hole of 3 P. D. out and above   | No operation         | 0                             |
|          |     | Second eye L, 60              | Hyperopia 1 D.                  | Fall; concussion of brain                                  | Hole of 3 P. D. above   | One operation        | +                             |
| 8        | F   | First eye R, 59               | Myopia ?                        | .....  | Seclusion; cataract   | No operation         | 0                             |
|          |     | Second eye L, 66              | Myopia 13 D.                    | .....  | Three holes; above, out and above and in and above  | Two operations       | —                             |

| 9  | M | First eye  | L, 55  | Myopia 2 D.                     | .....  | Seclusion and occlusion;<br>cataract  | Three operations | —                                |
|----|---|------------|--------|---------------------------------|--|---|------------------|----------------------------------|
|    |   |            |        |                                 |  |   |                  |                                  |
| 10 | M | Second eye | R, 60  | Myopia 2 D.                     | .....  | Hole of 1 P. D. down and out  | Two operations   | ± Count fingers<br>at 0.5 meter  |
|    |   | First eye  | L, ?   | Myopia 11 D.                    | .....  | Posterior cortical cataract;<br>opacity of vitreous; poor visi-<br>bility of retina                 | No operation     | 0                                |
| 11 | M | Second eye | R, 17  | Myopia 11 D.                    | .....  | Hole of 1½ P. D. temporally;<br>Slightly oblique crescent-shaped<br>hole of 3 P. D. out and above   | Two operations   | +                                |
|    |   | First eye  | R, 38  | Myopia 18 D.                    | .....  | a hemorrhage of 1½ P. D. at<br>10:30 o'clock  | Two operations   | —                                |
| 12 | M | Second eye | L, 48  | Myopia 14 D.                    | .....  | Crescent-shaped tear of 4 P. D.<br>at 12 o'clock  | Two operations   | +                                |
|    |   | First eye  | R, 34  | About emmetropic                | Slight blow at tem-<br>poral region                    | Complicated cataract  | No operation     | 0                                |
| 13 | M | Second eye | L, 60  | About emmetropic                | .....  | Partial cataract; opacity of<br>vitreous  | Five operations  | ± Count fingers<br>at 1 meter    |
|    |   | First eye  | L, 54  | Myopia 10 D.                    | .....  | Two large crescentic tears above<br>cent (?)  | Three operations | —                                |
| 14 | F | Second eye | R, 56  | Myopia 13 D. C<br>— 0.5 D. cyl. | .....  | Posterior synechia; cataract;<br>after extraction an old, com-<br>plete detachment presented itself | Seven operations | —                                |
|    |   | First eye  | R, 49  | About emmetropic                | .....  | Detachment 3 yr. old; no hole   | Two operations   | —                                |
| 15 | M | Second eye | L, 59  | About emmetropic                | Stroke on top of<br>head                               | Seclusion and occlusion<br>aphakia  | Four operations  | ± Count fingers<br>at 2.5 meters |
|    |   | First eye  | R, 34  | ?                               | .....  | No operation  | No operation     | 0                                |
| 16 | M | Second eye | L, 37  | Emmetropic                      | Injury to eye in child-<br>hood; traumatic<br>cataract | 2 large holes down and out  | One operation    | +                                |
|    |   | First eye  | L, 25  | ?                               | .....  | Proliferating retinitis after<br>periphlebitis  | No operation     | 0                                |
| 17 | F | Second eye | R, 26  | Emmetropic                      | .....  | Tear at equator out and above<br>from 9 to 11 o'clock   | One operation    | +                                |
|    |   | First eye  | R, 62½ | Myopia of about<br>18 D.        | .....  | Opacity of vitreous: large<br>tear out and above  | No operation     | 0                                |
| 18 | F | Second eye | L, 63  | Myopia of about<br>18 D.        | .....  | Large tear out and above<br>from 1 to 3 o'clock   | Three operations | —                                |
|    |   | First eye  | L, 63  | Myopia of about<br>18 D.        | .....  | Large tear out and above<br>from 1 to 3 o'clock   | Three operations | —                                |

*Data on Thirty-Three Cases of Bilateral Detachment—Continued*

| Case No. | Sex | Age When Detachment Developed        | Refraction                     | Injury  | Ocular Condition  | Number of Operations               | Result †                        |
|----------|-----|--------------------------------------|--------------------------------|---|---|------------------------------------|---------------------------------|
| 18       | F   | First eye L, 33<br>Second eye R, 43  | Myopia 10 D.<br>Myopia 9 D.    | .....<br>.....                                | Detachment 10 yr. old; no hole visible<br>degenerative hole of 1½ P. D. in and above  | Four operations<br>Six operations  | —<br>+                          |
| 19       | M   | First eye R, 50<br>Second eye L, 54  | Myopia 5 D. (?)<br>Myopia 5 D. | .....<br>.....                                | Seclusion and occlusion; cataract; operative scar of conjunctiva in and down; hole probably corresponds to this place<br>Degenerative hole of 1 P. D. in and down | Two operations<br>Eight operations | —<br>—                          |
| 20       | M   | First eye L, 22<br>Second eye R, 22½ | Emmetropia<br>Emmetropia       | Extraction of tooth (?)<br>.....              | Retinal cyst between 5 and 6 o'clock and 1 disinsertion from 3:30 to 5 o'clock<br>Retinal cyst and disinsertion of ora serrata between 6 and 7 o'clock            | One operation<br>Three operations  | +                               |
| 21       | M   | First eye 62*<br>Second eye 62*      | Myopia 12 D.<br>Myopia 12 D.   | .....<br>.....                                | Round hole of ¼ P. D. of the macula<br>Same as in first eye   | One operation<br>One operation     | —<br>+                          |
| 22       | M   | First eye L, 46<br>Second eye R, 51  | Myopia 10 D.<br>Myopia 10 D.   | .....<br>.....                                | Seclusion and occlusion; cataract<br>Great lobular hole at 1 and at 4 o'clock   | No operation<br>Five operations    | 0<br>± Count fingers at 1 meter |
| 23       | M   | First eye R, 25<br>Second eye L, 26  | Myopia ?<br>Myopia 13 D.       | .....<br>.....                                | Opacity of vitreous; poor visibility of fundus; no hole (?)<br>Degenerative hole of 1 P. D. nasally and one of ½ P. D. below the first                            | No operation<br>Two operations     | 0<br>+                          |
| 24       | M   | First eye R, 15½<br>Second eye L, 20 | Myopia ?<br>Myopia 13 D.       | Stroke in eye with iron<br>Concussion of head | Occlusion; cataract<br>Three holes of ¼ P. D. nasally   | No operation<br>One operation      | 0<br>+                          |

|    |   |            |         |                             |  |  |                  |                       |
|----|---|------------|---------|-----------------------------|--|--|------------------|-----------------------|
| 25 | M | First eye  | R, 56   | Same as second eye (?)      | .....  | Postoperative choroidal sears above and out; complete detachment                           | Two operations   | —                     |
|    |   | Second eye | L, 58   | Myopia — 6.0 D. — 2 D. cgl. | .....  | Hole of 4 P. D. above and out  | Four operations  | —                     |
| 26 | F | First eye  | L, 15   | Myopia 14 D. (?)            | .....  | Equatorial tear from 9 to 11 o'clock; retinal fold all around equator; opacity of vitreous | One operation    | —                     |
|    |   | Second eye | R, 18   | Myopia 14 D. (?)            | .....  | Equatorial tear from 4 to 6 o'clock; retinal fold nearly around equator                    | Two operations   | —                     |
| 27 | F | First eye  | R, 59   | Myopia 8 D.                 | .....  | Horseshoe-shaped hole of 2½ P. D. in and above   | One operation    | +                     |
|    |   | Second eye | L, 59½  | Myopia 8 D.                 | .....  | Somewhat smaller hole than in first eye, otherwise the same; no detachment                 | .....            | 0                     |
| 28 | M | First eye  | R, 24   | Myopia 7.0 D. — 1 D. cgl.   | .....  | Cataract (according to another clinic no hole was found before cataract developed)         | Three operations | —                     |
|    |   | Second eye | L, 26½  | Myopia — 6 D. — 0.5 D. cgl. | .....  | Tear above and in from 9 to 12 o'clock   | One operation    | —                     |
| 29 | F | First eye  | R, 22   | ?                           | Eye hit by branch  | Hypermatous cataract   | .....            | 0                     |
|    |   | Second eye | L, 27½  | ?                           | Stroke by cow's tail   | Total detachment visible after extraction of cataract; triangular hole above               | One operation    | —                     |
| 30 | M | First eye  | L, 25 ? | Myopia 12 D.                | Detachment manifest a couple of weeks after extraction of cataract | Complete detachment; no hole   | Two operations   | —                     |
|    |   | Second eye | R, 28 ? | Myopia 12 D.                | Same as in first eye   | Same as in first eye   | One operation    | —                     |
| 31 | F | First eye  | L, 43   | Myopia 18 D.                | Fall; bump of head   | Narrow lobular tear nasally  | Two operations   | —                     |
|    |   | Second eye | R, 44½  | Myopia 18 D.                | .....  | Same as in first eye   | Three operations | Treatment in progress |
| 32 | M | First eye  | L, 24   | Myopia 3.5 D.               | .....  | Degenerative round hole of 1 P. D. down and out  | One operation    | +                     |
|    |   | Second eye | R, 25½  | Myopia 3 D.                 | .....  | Same type of hole as in first eye, but ¾ P. D. and out and above                           | One operation    | +                     |
| 33 | F | First eye  | R, ?    | Myopia 17 D.                | Suffered a bump on head when a child                               | Old circumscribed detachment; no hole  | No operation     | 0                     |
|    |   | Second eye | L, 46½  | Myopia ?                    | .....  | Degenerative hole of 1 P. D. in and above  | Two operations   | —                     |

\* Simultaneously.

† In this column + indicates that the retina was reattached after a successful operation; ±, that circumscribed detachment occurred, with no change for one year at least; —, that the operation was not a success, and 0, that operation was not performed.



nected with senility. The number of all patients with detachment at the State Eye Hospital up to the age of 30 was 57; there were 213 over this age. The corresponding figures in Arruga's statistics are 109 and 572.

#### REFRACTION

Among the patients with bilateral detachment at the State Eye Hospital there were 25 with myopia, about three fourths of all the patients with detachment, 11 of them having myopia of 3 to 10 D. and 14 of them having myopia over 10 D. Maertens<sup>10</sup> found the majority of patients to show myopia of over 10 D. Fifteen of 31 patients of Dunnington and Macnie<sup>9</sup> had high myopia. The percentage of myopia in the statistics of Arruga,<sup>8</sup> in cases both of unilateral and of bilateral detachment, is 58. In the series from the State Eye Hospital myopia of the same degree was present in the two eyes of 9 patients, the opacity of the media preventing determination of the difference in 8 patients. A higher degree of myopia existed in the first eye than in the second eye of 4 patients, and 1 patient had a higher degree of myopia in the fellow eye. Thus if there is any difference of refraction, the probability of detachment is much greater in the eye with the higher degree of myopia.

#### INJURY

On the basis of considering extraction of cataract as an injury, 4 patients in the series from the State Eye Hospital suffered injury of both eyes (cases 6, 24, 29 and 30 in the accompanying table). Seven patients suffered injury of only one eye, 5 of the injuries being indirect, such as a fall or a bump of the head. Only 2 suffered actual injury directly, i. e., extraction of cataract and perforating wound.

#### RETINAL HOLE

The retinal hole was seen in the first eye in only 9 cases. Complicated cataract in 11 cases and opacity of the vitreous or old detachment with stiff folds in 13 cases prevented the finding of the hole. In a series of 27 cases of bilateral detachment Weve and van Manen<sup>11b</sup> noticed 20 cases of complicated cataract in the first eye.

One or several holes were present in the second eye in 29 of the cases in the State Eye Hospital series. The types of holes were as follows: lobular or horseshoe-shaped, 19 cases; a large peripheral tear, 6 cases; disinsertion of the ora serrata, 1 case; a round degenerative hole, 11 cases, and a macular hole, 1 case. On the basis of the three main groups, the holes were distributed as follows: lobular and large tears, 16 cases; disinsertion of the ora serrata, 1 case; degenerative holes, 12 cases. Gonin gives the proportion of these types as follows: 68, 10 and 22 per cent, respectively.

Thus in the present series the hole was visible in both eyes in 9 cases (7, 11, 13, 17, 20, 21, 27, 31 and 32 in the table). In 3 additional cases the hole in the first eye could be determined by the previous history or records made in another hospital. In all, 12 pairs of eyes could be compared as to the location and the type of the hole. In each of the cases it was of the same type, and in only 2 cases (32 [fig. 9] and 33) was the location different, i. e., the degenerative hole developed at asymmetric points. Lobular or horseshoe-shaped holes (cases 7, 11 [fig. 2], 13 [fig. 3], 25 [fig. 6], 27 [fig. 7] and 31 [fig. 8]), a large peripheral tear and a degenerative hole (case 19), a macular hole (case 21 [fig. 5]) and a disinsertion due to a cyst (20 [fig. 4]) were located symmetrically in both eyes. The slight differences are certainly due to the difference in the duration of the detachment in the two eyes.

The symmetry of type and place of the hole in the two eyes is striking. I found several such instances reported in the literature, chiefly in the form of disinsertion at the ora serrata. Five of 10 such detachments combined with the retinal cyst of Weve<sup>16</sup> were binocular and symmetric, the average age of the patients being 20 years and 6 months. Janke,<sup>17</sup> Kurz<sup>18</sup> and Schiff-Wertheimer and Juvanon<sup>19</sup> reported similar cases. Jess<sup>20</sup> and Csillag<sup>21</sup> each observed a case of binocular cyst. In Csillag's case disinsertion of the ora serrata developed later in one eye. Symmetric disinsertion without a cyst was seen by Vogt,<sup>22</sup> by Schmelzer<sup>23</sup> in 2 brothers aged 26 and 33, by Manen<sup>11a</sup> (case 30) and by Meisner<sup>24</sup> and by vom Hofe<sup>25</sup> in patients aged 35 and 34 years, respectively.

16. Weve, H.: Die Beziehungen zwischen den grösseren isolierten Netzhautcysten und Netzhautablösung, *Arch. f. Augenh.* **109**:49, 1935.

17. Janke: Echte Netzhautzysten und Netzhautablösung bei Jugendlichen, *Klin. Monatsbl. f. Augenh.* **95**:145, 1935.

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19. Schiff-Wertheimer, S., and Juvanon, L.: Le décollement bilatéral de la rétine, *Bull. Soc. d'opht. de Paris* **49**:208, 1937.

20. Jess: Besondere Fälle von Ablatio retinae und ihre Heilung, sowie über Netzhautzysten, *Klin. Monatsbl. f. Augenh.* **96**:531, 1936.

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23. Schmelzer: Doppelseitige Netzhautablösung mit symmetrischen Orariss, *Klin. Monatsbl. f. Augenh.* **95**:394, 1935.

24. Meisner, W.: Zum Vorkommen und zur Entstehung der Netzhautablösung, *Klin. Monatsbl. f. Augenh.* **97**:289, 1936.

25. vom Hofe, K.: Netzhautablösung und Lebensalter, *Klin. Monatsbl. f. Augenh.* **93**:745, 1934.



Fig. 2 (case 11).—Fundi of the patient in case 11. In this and the following illustrations the upper figure shows the fundus of the left eye and the lower figure that of the right eye. The left eye (upper figure) was successfully operated on in the early stage, shown here. The hole in the right eye is of the same size and shape as that in the left eye. It is at 11 o'clock; in the left eye it is at 12 o'clock. This difference may have been due partly to the intensive bulging of the right retina.

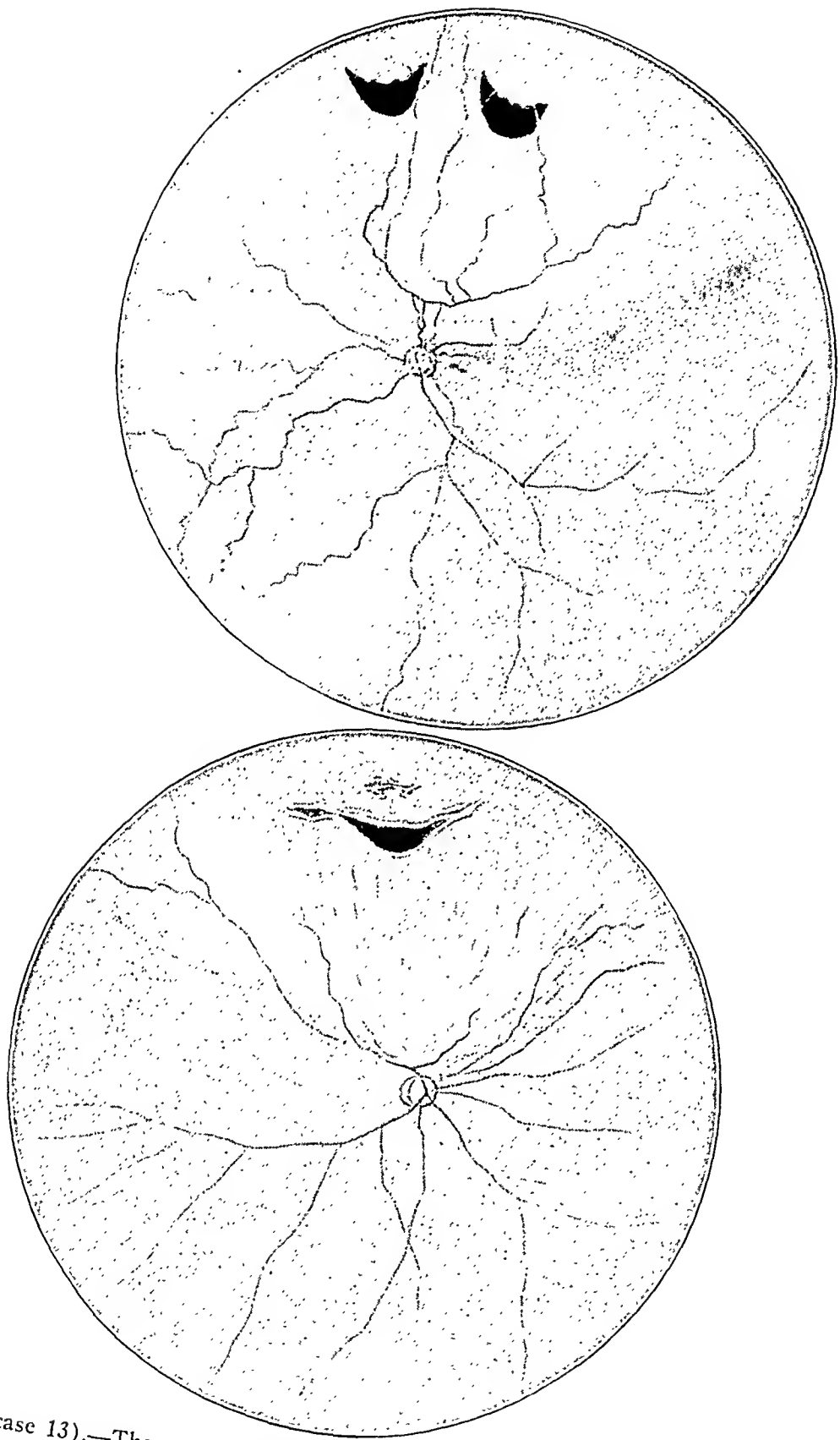


Fig. 3 (case 13).—There are two crescentic holes above in the left eye. The right eye has one, probably the result of two confluent holes.

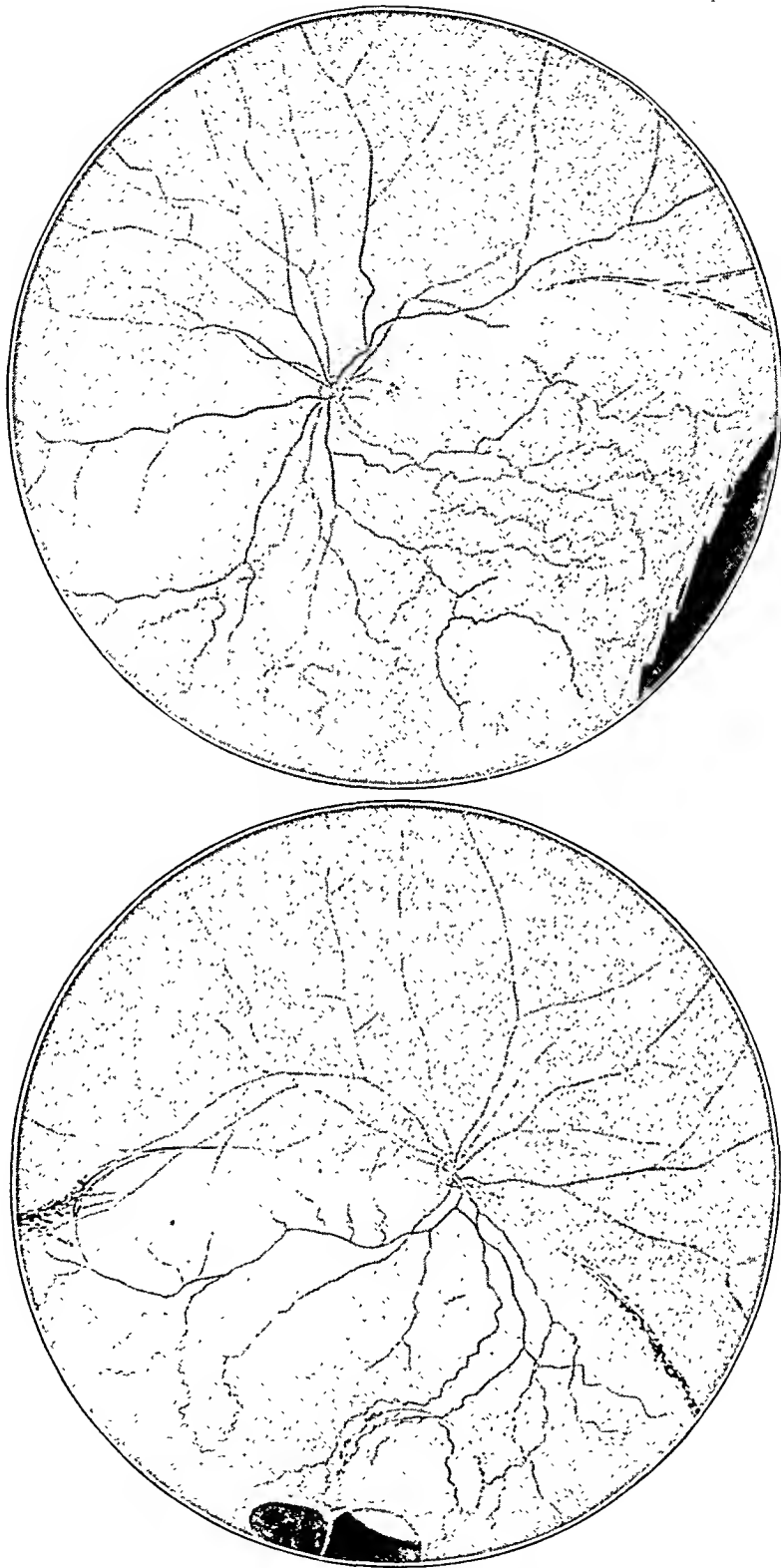


Fig. 4 (case 20).—The retinal cyst is at about the same place in the two eyes, but the disinsertion at the ora serrata, though in the same quadrant, does not correspond. A line of choroiditis shows the demarcation of detachment in both eyes.



Fig. 5 (case 21).—The same degree of detachment is shown around the macular hole in the two eyes. The hole of the right macula is slightly larger.

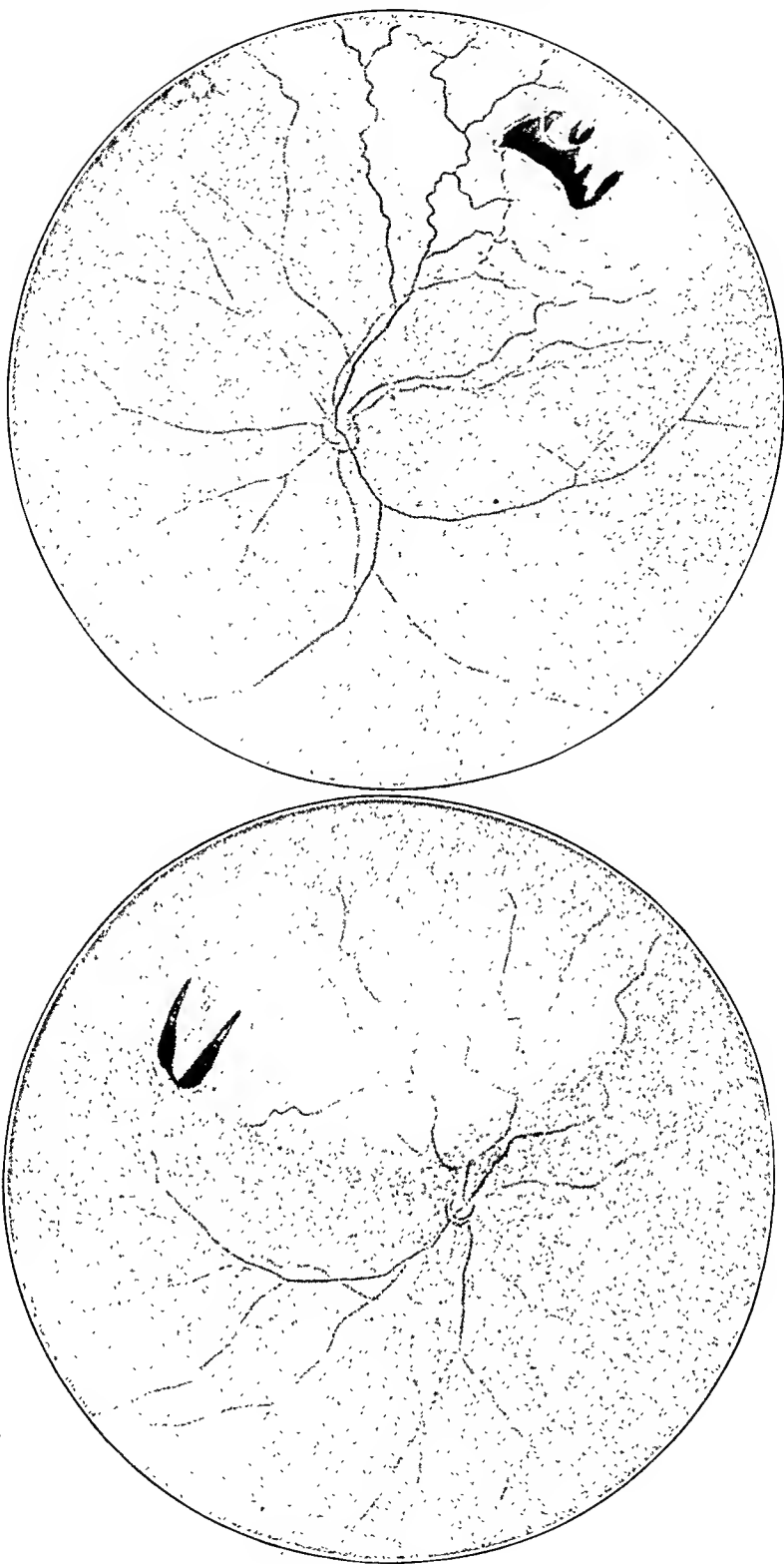


Fig. 6 (case 25).—The fundi before the operation. The retinal flap of the left eye is ragged. When detachment developed in the left eye, there was total detachment and postoperative choroidal pigmentation around the hole in the right eye.



Fig. 7 (case 27).—A horse-shoe shaped hole was produced in the right eye at the same place as that in the left eye, but detachment did not follow.





Fig. 8 (case 31).—An unusually narrow tear is shown in the left eye nasally. The tear in the right eye is not quite so narrow, and there is a visible small retinal flap at the corresponding place. Macular atrophy due to high myopia occurred in the right eye.

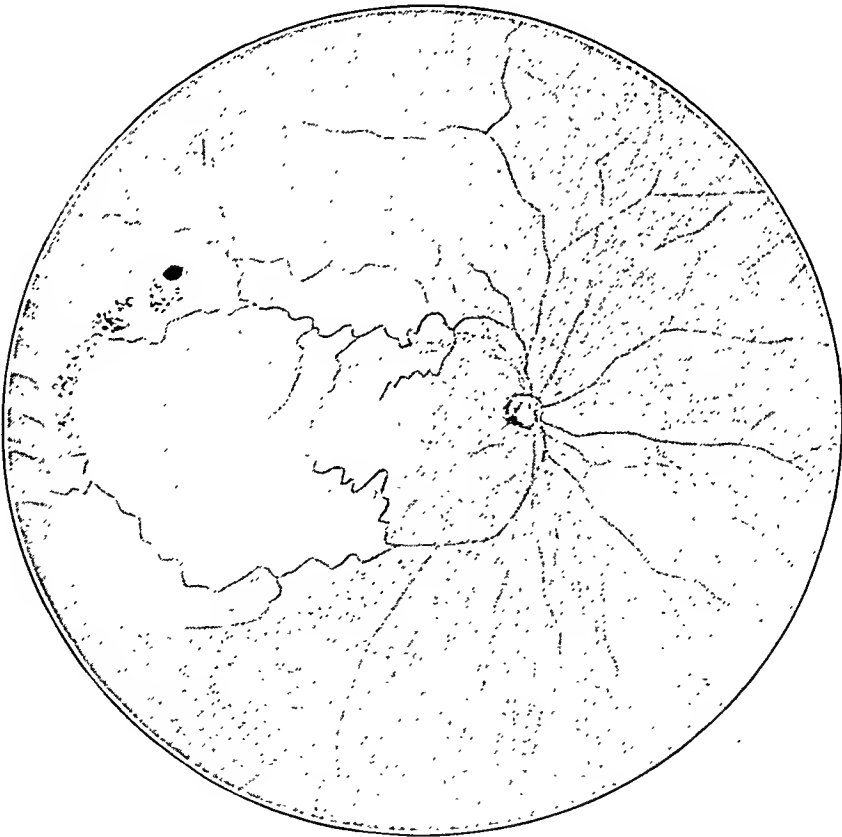
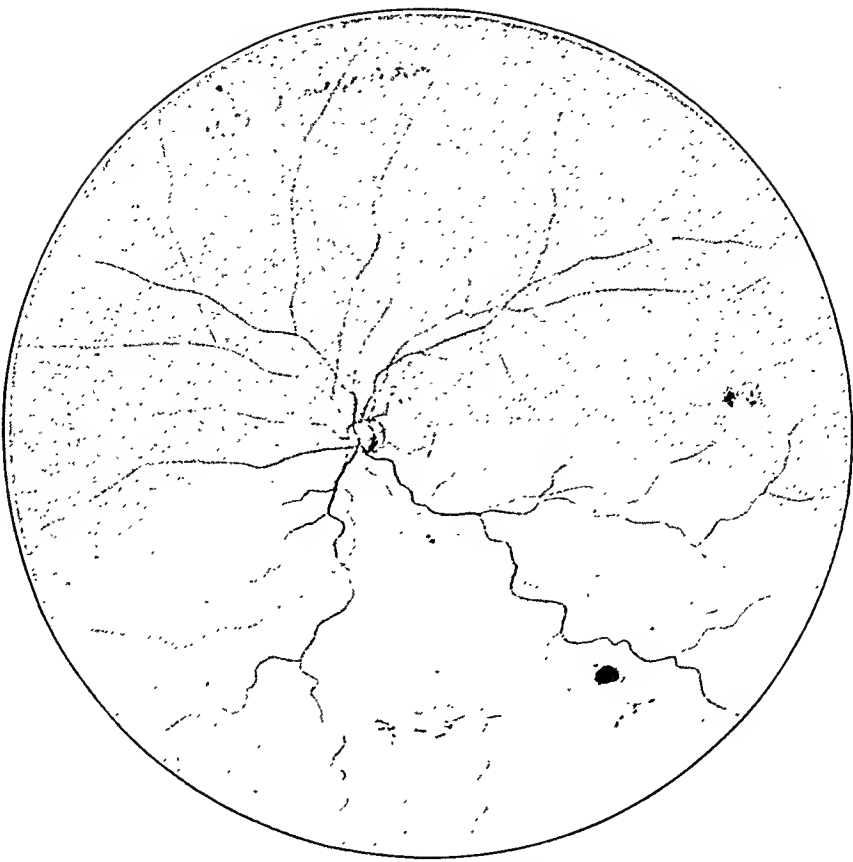


Fig. 9 (case 32).—The same kind of degenerative round hole of about 1 papilla diameter and punctiform retinal hemorrhages are seen in the two eyes. However, the hole in the right eye is above and that in the left eye is below the horizontal meridian.

Pischel<sup>26</sup> reported on successful operation on both eyes fourteen and twenty-eight months respectively after the first operation for the detachment. This condition was already known by Leber. Schiff-Wertheimer and Juvanon<sup>19</sup> stated that one group of bilateral detachments is composed of disinsertions of the ora serrata. Several authors supposed that this part of the retina is congenitally a locus minoris resistentiae (Löhlein<sup>27</sup> and Meisner<sup>24</sup>). Only 1 case (20) in the series from the State Eye Hospital belongs in this group.

A large peripheral tear caused bilateral detachment in case 17 in this series and probably was the type in eyes 5 and 6 in the series of Gifford.<sup>12</sup> Symmetric multiple lobular tears were observed in the temporal halves of the 44 year old patient of Maertens.<sup>10</sup> In her 31 year old patient the lobular hole was in the upper temporal quadrant. Symmetric multiple degenerative holes in the upper temporal quadrant are described by Meisner.<sup>24</sup> One patient with 12 to 13 D. of myopia suffered detachment in the first eye at the age of 24 and in the fellow eye four years later. Another patient with 18 D. of myopia was struck in the eye with a finger, and several degenerative holes in the temporal quadrant and a macular hemorrhage resulted. The other eye had suffered spontaneous detachment two years previously and showed two holes, also temporally. The holes in the retinas of Gifford's<sup>12</sup> 22 year old patient (eyes 22 and 23) were above, with detachment down. Such a hole might be degenerative or lobular.

This short review of the literature concerning symmetric holes in cases of binocular detachment disclosed chiefly disinsertions, while in the series of cases from the State Eye Hospital the holes were mainly lobular.

#### OPERATIVE RESULTS

The first eye was not operated on in 18 of the cases in this series. This is a large number, though the poor prognosis of the operative treatment of detachment withheld many from operation. A great number of the detachments of the first eye occurred before 1929, in which year Gonin's method made its triumph at the Thirteenth International Ophthalmologic Congress. Nine eyes were operated on in other hospitals, with successful results in 1. Seven eyes were operated at the State Eye Hospital, with successful results in 2.

In 2 cases the fellow eye was not operated on; 1 recovered spontaneously (case 2) and in the other (case 27) the retinal flap of a horse-shoe-shaped hole was hanging in the vitreous, but no detachment

26. Pischel, D. K.: An Unusual Case of Bilateral Retinal Detachment, *Am. J. Ophth.* **19**:795, 1936.

27. Löhlein, W.: Ueber Netzhautablösung und ihre Behandlung, *Zentralbl. f. d. ges. Ophth.* **24**:289, 1931.

developed. Seventy-seven operations were performed on the other 31 eyes. Full recovery and useful vision was obtained in 12 cases (39 per cent); the operation was not completed in 1, and improvement occurred in 5. Improvement was noted when the hole was fixed to the choroid but when partial detachment still was present and when this had been the condition for one year at least. According to Schiff-Wertheimer and Juvanov<sup>19</sup> and to Maertens,<sup>10</sup> the prognosis of binocular detachment is poorer than that of monocular detachment. The statistics of the latter show 4 recoveries among 20 cases of binocular detachment. Fodor<sup>3</sup> stated that binocular detachment has the poorest prognosis of all types of detachment. Contrary to this, Lindner<sup>28</sup> gives the history of 2 patients. He operated on the fresh detachment of the fellow eye. During a period of rest in bed after the operation and while the patient was wearing the hole spectacles, the detachment in the first eye subsided. Gifford<sup>12</sup> operated on 7 patients who had a detachment in the other eye. He obtained 5 recoveries, in 1 instance in each eye of the patient.

Of the series of 33 patients with binocular detachment at the State Eye Hospital, 13 became blind in each eye, 1 is under treatment and 5 have poor vision, being able to count fingers at 0.5 and 2.5 meters. This series also proves the poorer prognosis of binocular detachment. In this material this is due to the relatively great number of cases in which a large tear occurred near and parallel to the ora serrata. This condition attacks chiefly the young (9, 18, 26, 26½, 37 and 62 years of age in this series). Only 1 of these patients recovered. These tears occupying one sixth to one half of the circumference of the retina are not to be confused with the benign disinsertion of the ora serrata. In the group of the unsuccessfully treated eyes, there are 2 in which exploratory cataract extraction justified the diagnosis of detachment. Detachment leading to cataract is always one of long standing, and there is little chance if any of recovery. One other factor explaining the poorer prognosis of bilateral detachment may be the fact that the second eye was operated on when the patients were on the average five years older. When the 6 cases of detachment with large tears and these 2 cases complicated with cataract are subtracted, the rate of recovery (11 of 23) is about the same as is usual in cases of unilateral detachment.

#### PATHOGENESIS OF BINOCULAR DETACHMENT

The binocular occurrence of this disease permits one to form certain ideas as to its pathogenesis. The similarity of the tear, its occurrence within a few years in the two eyes and the previous history, which in the

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28. Lindner, K.: Bemerkenswerte Fälle von Netzhautabhebung. *Ztschr. f. Augenh.* 90:223, 1936.

majority of cases shows no injury, make an endogenous cause probable. Hormonal, metabolic and inflammatory origin may be ruled out. The frequency of inflammatory origin of detachment was recently supported by Sabbadini<sup>29</sup> and Kurz.<sup>18</sup> I believe that this causation can be accepted for cases in which there are signs of recent or old choroiditis and for cases in which there is no retinal hole. Three such cases in the series at the State Eye Hospital are: case 2, in which there was no hole but demarcated detachment and lordosis; case 14, in which there was no hole in either eye and case 16, in which detachment was preceded by retinal periphlebitis. As to the constitutional factor, there were 8 patients of the pyknic type and 8 of the asthenic type. The number of patients is too small on which to base conclusions, but this series did not have the high proportion of asthenic persons that Incze<sup>30</sup> and Franke<sup>31</sup> found among persons with myopia.

There is but one possibility left to explain the detachment or the formation of the hole, i. e., a congenital predisposition, a property of the germ plasma. Vogt<sup>32</sup> is the founder of this theory. According to him the liability to presenile and senile degeneration of the vessels, choroid and vitreous preceding the hole is hereditary. Cystic degeneration following the obstruction of the peripheral retinal vessels (Vogt<sup>33</sup>) is the most important factor in this respect. Often exogenous circumstances are needed, too, to develop a hole even if there is a predisposition to it. Thus the primary cause of the detachment lies in a hereditary stigma which determines the senile degeneration, chiefly, that of the vessels. Zur Nedden<sup>34</sup> affirmed this theory as follows: "The development (i. e., of the detachment) is determined through heredity. It occurs without any external causation sooner or later according to the different intensity of the degeneration and the degree of its further development."

Senile cystic degeneration is general at a certain age. Should cystic degeneration cause the detachment, then the number of cases of detachment would show a marked increase with age. This is a fact, indeed, up to a certain age (fig. 1). However, beginning with the sixtieth year the curve of detachment drops parallel to that of the population,

29. Sabbadini, D.: *Etiologia del distacco di retina*, Rome, tip. Regionale, 1937.

30. Incze, A.: *Körperbau und Refraktion*, *Ztschr. f. Augenh.* **66**:50, 1928; *Ueber die Myopie als eine konstitutionelle Veränderung*, *ibid.* **67**:20, 1929.

31. Franke, E.: *Körperbau und Refraktion*, *Klin. Monatsbl. f. Augenh.* **101**: 134, 1938.

32. Vogt, A.: *Ueber Berührungspunkte der senilen und der myopischen Bulbusdegeneration*, *Klin. Monatsbl. f. Augenh.* **72**:212, 1926.

33. Vogt, A.: *Ueber zystoide Retinadegeneration und die begleitenden Liniennetze*, *Klin. Monatsbl. f. Augenh.* **92**:743, 1934.

34. zur Nedden, M.: *Vererbung der idiopathischen Netzhautablösung*, *Klin. Monatsbl. f. Augenh.* **97**:236, 1936.

while if cystic degeneration played the decisive role the number of detachments should further increase. But it may be that cystic degeneration is a symptom of early, not of late, senility; or in certain cases this degeneration may not be related to senility at all but may be due to an inborn property of the germ plasma. Vogt<sup>35</sup> reported on 4 patients aged 18 (with binocular detachment), 18, 26 and 28 years, respectively, who suffered from spontaneous disinsertion of the ora serrata. The surrounding retina showed severe cystic degeneration.

The curve for the cases of bilateral detachment is flat, without the peak of the curve for the cases of unilateral detachment. Therefore, it appears that a considerable number of cases of bilateral detachment, especially those in young persons, represent another biotype. The disease seems to be caused by abiotrophy—heredodegeneration of the retina, as in systemic degeneration of the nervous system. The retina as a portion of the central nervous system may also have a predisposition to degeneration lying in the genotype. The heredodegenerative diseases of the nervous system occur with different gravity in different families, but in members of one family in the same way. This degenerative retinal disease, as it is well known, also shows different types. One is disinsertion at the ora serrata with or without cyst, in which cases the refraction and condition of the vitreous have no importance. Weve<sup>36</sup> detected a familial development, falciform detachment, always occurring temporally and down, just like the symmetric disinsertion of the ora serrata. Falciform detachment represents a condition in which one portion of the retina is certainly congenitally defective. The large peripheral tear parallel to the ora serrata is another biotype among the retinal holes. Occurring in youth and occupying one fourth to one half of the periphery, it has nothing in common with senile degeneration. The horseshoe-shaped or lobular holes are almost always combined with myopia and with degeneration of the vitreous. In these cases the mechanical effect, pulling by the vitreous, may also be a factor aside from the degeneration of the retina. Finally, I shall consider the small degenerative round holes. In this biotype a vascular degeneration is mostly present, i. e., a condition due to trophic disturbance; according to Vogt's theory, primary damage occurs in the vessels, not in the retina as is supposed in the other biotypes. The single biotypes do not transform into each other; each begins in its typical form. It is unlikely

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35. Vogt, A.: Zystoide Degeneration als Ursache grosser spontaner Ora-abrisse der Netzhaut und Heilung solcher Risse durch Katholyse: Experimentelles zur Proversio des Netzhautlappens, *Klin. Monatsbl. f. Augenh.* **96**:10, 1936.

36. Weve, W.: Ueber "Ablatio falciformis cong.," *Arch. f. Augenh.* **109**: 371, 1935.

that the horseshoe-shaped hole may originate from a round cystoid hole; it starts as a horseshoe-shaped hole, although in the latter course it may enlarge.

To support Vogt's theory, Richner<sup>37</sup> searched the literature on detachment from the point of view of heredity and found 18 cases of familial origin. In the material of Vogt he found listed 32 families, in each of which there were at least 2 cases of detachment. Recently Vogelsang,<sup>38</sup> Schmelzer<sup>23</sup> and zur Nedden<sup>34</sup> reported such cases. B. Friedman<sup>39</sup> saw a family of 7, 5 of whom suffered from detachment. Zimmer<sup>40</sup> gathered reports of 34 cases from the literature; he also cited the 2 families reported by Gonin, the 2 reported by Schiff-Wertheimer and Juvanon and the 3 reported by Amsler. Zimmer stated that in the same family the same type of detachment occurs and mostly in the same eye. I observed familial detachment in the following 2 brothers and a sister.

W. M., a 63 year old man, suffered a blow on the left side of his face when thrown by a horse two and a half months before being treated for detachment. He observed a curtain before the left eye for ten days before. There was a horseshoe-shaped hole in the left eye of 4 papilla diameters which was crossed by a vessel at 1:30 o'clock at the equator. Perforating diathermy and ignipuncture were used (Professor Imre). Vision in this eye was 5/12 with a -0.5 D. sph.  $\ominus$  + 1.5 D. cyl., axis 180.

W. J., a 49 year old man, underwent cataract extraction on the left eye with iridectomy one year before treatment for detachment and on the right eye one-half year before. In the right eye at 1:15 o'clock there was a horseshoe-shaped hole of 2 papilla diameters crossed by a vessel. Penetrating diathermy and ignipuncture were employed (Professor Imre). There was a recurrence, and one month later a second operation resulted in definitive healing. Vision was 5/12 with a + 9.0 D. sph.

W. S., a 68 year old woman, suffered from diminution in the vision of the left eye for eight days. At 11:30 o'clock there was a hole of 3 papilla diameters, in the middle of which there is one thread (vessel?). Ignipuncture and penetrating diathermy were employed (Professor Imre) with recovery. Later there was a recurrence. A second operation like the first resulted in definitive recovery. Vision was 5/70 with a - 9.0 D. sph.

To summarize, 2 brothers and a sister suffered from detachment. The latter acquired it spontaneously at the age of 62; 1 brother acquired it at the age of 63 after an indirect injury and the other brother at

37. Richner, H.: Vererbung der Netzhautablösung, Arch. f. Ophth. **135**: 49, 1936.

38. Vogelsang: Zur Erbpäthologie des Auges, Klin. Monatsbl. f. Augenh. **98**: 252, 1937.

39. Friedman, B.: Familial Degeneration of the Retina Leading to Detachment of the Retina: Report of a Case, Arch. Ophth. **17**:382 (Feb.) 1937.

40. Zimmer, M. S.: Contribution à l'étude du caractère familial du décollement rétinien idiopathique, Inaug. Dissert., Lausanne, 1937.

the age of 49 after cataract extraction. In 2 of these patients it presented itself in the left eye and in 1 in the right eye, at the equator at 1:30 and 1:15 o'clock, respectively. All showed a horseshoe-shaped hole crossed by a vessel. The 49 and the 63 year old patients were practically emmetropic; the third had myopia of 9 D. The youngest patient's detachment obviously was precipitated by the cataract extraction. Detachment following cataract extraction is generally considered as due to loss of vitreous. But how can one explain the detachment in the 3 cases of Dr. Gifford<sup>41</sup> in which it occurred in both eyes after cataract extraction, though the extraction and recovery of the second eye were normal?

#### SUMMARY

In 33 cases of binocular retinal detachment the average age of patients when detachment developed in the first eye was 39 years and in the fellow eye, 44. In 70 per cent of the cases the interval between the outbreak of the disease in the two eyes was within five years. Forty-two per cent of the patients were young persons up to 30 years of age. Injury played a subordinate role. Each type of retinal hole was observed, but each eye always showed the same type of hole as its fellow—horseshoe-shaped or lobular holes, degenerative holes, disinsertion at the ora serrata or large peripheral tears. In addition to the type being the same, the holes occurred mostly at a symmetric part of the retina. The prognosis is poorer with bilateral than with unilateral involvement. This is caused by the malignancy of the condition in the relatively great number of cases of large peripheral tears in young persons.

The occurrence of binocular detachment, especially its uniformity in the two eyes, supports the view of Vogt concerning the pathogenesis of this disease, that disposition to develop a hole is a consequence of presenile and senile degeneration of the retina, vitreous, choroid and vessels. The disposition is a congenital property of the germ plasm. I have gone one step further in considering one group of binocular detachments as a primary heredodegenerative disease which does not depend on senility. Retinal holes, especially the degenerative type occurring in senility, may be the result of secondary retinal degeneration following the occlusion of the vessels. The probability of heredodegeneration is supported by the occurrence of familial detachment, to which this paper makes a contribution.

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41. Gifford, S. R.: Personal communication to the author.



# THE BETTS VISUAL SENSATION AND PERCEPTION TESTS

A METHOD OF DETECTING SCHOOL CHILDREN REQUIRING  
OCULAR ATTENTION

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The staff of the Research-Learning Project,<sup>1</sup> which is concerned with studies of child development and school failure, found it necessary to make a subsidiary investigation of the methods of testing vision and of facts concerning the visual equipment of groups of children before proceeding with the main work of the project. This paper reports a study of a battery of tests purporting to indicate persons who need ocular attention.

Many records of teachers' tests with Snellen charts, as usually given in the schools, had been examined previously and were found to be insufficient and unreliable. Teachers themselves expressed dissatisfaction with the results. They admitted faulty procedures, such as inaccurate measurement of the 20 foot (6 meter) distance, poor lighting and the opportunity given the children for memorizing the charts. It is a patent fact that records made with Snellen charts under present testing conditions in most of the schools cannot be accepted with any degree of confidence.

Confronted with the necessity of obtaining visual data for large numbers of children, the members of the staff turned to a study of other existing tests designed to detect school children who need an eye specialist's attention. Our attitude toward the study was expressed somewhat as follows: Until such time as practicable means can be found for the examination of all school children by a qualified eye specialist it will be necessary to rely on some procedure in the schools which will screen out those who need particular attention. Such screen-

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1. Sponsored by the Division of Child Hygiene, Massachusetts State Department of Public Health, M. Luise Diez, M.D., Director. The major investigation covers a study of causes underlying early failure in school. In addition to the authors, the other members of the staff are J. W. M. Rothney, of Harvard University, who supervised the statistical work, and Miriam Forster, who did most of the testing with the telebinocular method and assisted in the statistical work.

ing out by nonprofessional persons will result in some degree of error, but we would not advocate dropping such effort or refuse to improve existing procedures until such time as the ideal objective can be achieved. Educators are disturbed over the ineffectiveness of present devices for testing vision and are trying out new material offered by commercial companies to meet the situation. A careful appraisal of some of these tests is needed.

The material used in this study is the DB series of the Betts tests.<sup>2</sup> It is advertised for use by persons without special training. It consists of several slides used in a stereoscope (designated as the ophthalmic telebinocular) to test visual efficiency (acuity), binocular function, fusion and stereopsis. The novel mechanical features of the instrument and the attractiveness of the material have readily commended them to large numbers of school authorities. An examination of the test material reveals an effort to bring together several features which are believed to be essential to a good screening test. There are eight tests, a brief description of which follows:

1. Introductory test. This test is intended to elicit interest of the child and to check whether he is using both eyes.

2. Test for distant fusion. This test utilizes four colored circles seen as three by two eyes at infinity as computed on the stereoscope.

3. Test for visual efficiency. This test employs a device with three slides designed to determine the visual acuity of the two eyes together, then the vision of each eye alone while the other eye is open and directed to dots of decreasing size arranged on a picture background.

4. Test for vertical imbalance. With this test a horizontal line is presented to one eye and a ball, star and box arranged one above the other to the other eye.

5. Test for coordination level. With this test an attempt is made to measure depth perception by means of disparateness of images.

6. Test for lateral imbalance. With this test a vertical arrow is presented to one eye and a horizontal row of numbers to the other eye.

7. Test for reading distance fusion. This test utilizes four colored circles seen as three by two eyes at a reading distance as computed on the stereoscope.

8. Test for sharpness of image. This test is designed to test "errors of focus" by counting the number of black lines (arranged in different meridians) within yellow circles. The circles containing three lines are recorded; the others with one, two and four lines serve as "dummies."

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2. Betts Visual Sensation and Perception Tests, DB series, Keystone View Co., Meadville, Pa.

The form of these tests is attractive because of the following features: (1) seeming simplicity of administration, (2) novelty and (3) inclusion of tests designed to detect (a) lowered visual acuity and (b) disturbances of binocular vision.

While it is not assumed that visual abnormality can generally be detected as efficiently with a test for use in schools or by lay persons as by a qualified eye specialist, two conditions may be safely set up. 1. Children with errors of high degree should be discovered. Any inaccuracy in the test should be in the direction of pointing to questionable or borderline cases. A somewhat higher number of children, when compared with those needing correction, would be screened by such a test. 2. To be practicable, however, the number referred unnecessarily should not be so high as to embarrass the school health division or belittle the value of the test.

Reports received at our office concerning results of the tests under investigation when used to sort out school children needing an eye specialist's attention were conflicting and perplexing. They varied from enthusiasm to condemnation. Most of the comments received by us referred to the problem of correct interpretation of test results. By following the manual of directions,<sup>3</sup> it was found by some examiners that nearly all the children tested needed ocular correction. Follow-up examinations by local eye specialists did not bear out these findings sufficiently to justify continued use of the tests in some of these schools. Parents complained when they were put to the expense of examination by a specialist only to be told that there was no visual disorder. In some communities a large number of referred children were given corrections, yet later it was found that sometimes plano lenses or plus 0.25 spheres only had been prescribed.

A wide variation in the discrepancies among the children screened out for attention and those given corrections by the eye specialists appeared among the several communities from which reports were available. This variation is probably due to a number of factors. Among there are:

1. The private specialists have included optometrists, general physicians doing ophthalmic work and ophthalmologists. This variation brings about certain differences in diagnosis.

2. Tests for binocular functions were omitted by some of the examiners.

3. The examiners differed in opinion regarding the importance of certain binocular functional errors and in specific attitudes favoring or opposed to orthoptics.

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3. Betts, E. A.: *The Prevention and Correction of Reading Difficulties*, New York, Row, Peterson & Company, 1936, pp. 310-379.

4. The variability of opinions for determining criteria for limits of errors requiring treatment was wide.

5. There were appreciable differences in the findings of this series of tests when used by persons of different degrees of training and intelligence, even when following the same instructions.

Our purpose was to study this series of tests with a view to determining their efficiency, especially when used in the schools. In order to minimize the variable factors mentioned here regarding the follow-up examinations by persons with different kinds of training and employing widely different criteria for referral, the investigation was planned in such a way (1) that a single ophthalmologist should examine all of the children, that (2) tests for binocular functions should be included in his examination and that (3) specific criteria should be set up as a basis for referral.<sup>4</sup> The present study is directed primarily to the question: Does the vision testing material as it is dispensed and used in schools serve to sort out the children who should be referred to an eye specialist?

#### METHOD OF STUDY

Two groups of 100 children each were included in the investigation. Group A was composed of children living in rural or semirural districts. Their ages ranged from 9 to 15 years. They were all suspected of having visual difficulty by their teachers or were handicapped in reading. Sixty-five were boys, and 35 were girls. Group B consisted of an entire fourth grade in a town school and all of the children in two rural schools. They ranged in age from 6 to 15 years. There were 51 boys and 49 girls.

The children included in this study probably present a fair sampling of the public school population of Massachusetts exclusive of the large metropolitan areas. In socioeconomic status they represent such groups as families on relief, fishermen, farmers, professional men, college professors and business men. The majority attend village and rural schools in the western part of the state; the others live in a town on Cape Cod.

The telebinocular tests were given twice to each of the 200 children. For group A, the second series of tests was administered approximately a year after the first, and all were given by the same person, the research assistant of the staff, who is experienced in teaching and trained in giving educational tests. Two school nurses administered

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4. The report which follows should not be construed as a commentary on the principles underlying the tests themselves or of the mechanical construction of the instrument. To our knowledge the stereoscope had been examined and approved in its mechanical features by at least one well known ophthalmologist. It should be kept in mind that several functions are claimed for the telebinocular tests in connection with other types of materials. The present study is an investigation of one function only. No effort was made to substantiate or to discredit the theory of functional disorders of the eye with which these tests are concerned.

the tests to the children of group B. One gave them to all of the rural school children, and the other gave them to the fourth grade class in the town. For all of these children the second series of tests were given within a month of the first. Each nurse had received more than an hour's instruction in the use of the tests and was instructed to study the manual and to be guided by the directions contained therein. Because of errors and omissions in recording, it was necessary to have a member of our staff retest and check the results for about 40 children of group B. In all instances there was no reference to the record of the previous tests while the second series was being given. The testing was done individually in private rooms. The results of these 400 individual tests were tabulated to indicate the children for whom the attention of an eye specialist was indicated by the telebinocular record.

Each of the 200 children was then examined by the staff ophthalmologist, who indicated in each report whether or not, according to his findings, the child should be referred to a specialist.

The two records of the telebinocular tests, taken singly and together and interpreted by several criteria, were then compared with those made by the ophthalmologist.

An explanation of the scoring procedures used for the telebinocular tests, a description of the ophthalmologist's screening tests and the method used by him for making recommendations to the school authorities concerning the need for more complete ocular examination need some elaboration in order to show the extent to which the investigation was carried.

The first tabulations made of the telebinocular tests, scored according to the manual of instructions, indicated an extraordinarily high number of children to be sent to an eye specialist for diagnosis. Since our experience corroborated other reports that there was general confusion among those using the telebinocular tests over the question of how to determine which children among the large numbers screened out should be sent to eye specialists, a representative of the manufacturer's staff was consulted and his services enlisted in order to check our records for possible errors of interpretation. Wide experience in giving the tests had made it possible for him to work out what he considered to be a more satisfactory "system" of scoring<sup>5</sup> than that given in the manual. He was asked to go over the record sheets and to make independent

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5. His own description of his "system" is briefly as follows: Tests 3 (visual efficiency) and 8 (sharpness of image) are the only single tests in which failure is considered a basis for referral of the child to an eye specialist. A record lower than 90 per cent with any of the three subtests of test 3, is considered failure and a record of 105 per cent or higher with all three subtests is considered a basis for referral. Failure to see three lines on any of the yellow test balls used for

recommendations on the basis of his plan for interpreting the scores. The tables presented here show comparisons between his (expert) interpretations, those made according to the manual and the recommendations made by the ophthalmologist. In all instances in which interpretations and recommendations were made from test records or examinations there was no reference to any records except those immediately under consideration. The tabulations were done by a third person whose accuracy was checked by an office assistant.

Preparations for all the tests by the ophthalmologist were made beforehand on each occasion. Two consecutive days were usually given to these surveys in each community. An examining room was set up in any convenient space—a vacant school room, a town hall or a school auditorium. The children were brought for examination in small groups and provision was made so that all had an opportunity to observe the procedures from a distance before they were tested. The fact that all were eager and willing to cooperate made it possible for the ophthalmologist to examine a comparatively large number of children in one day. The examination included:

- Visual acuity test, each eye separately and the two eyes together
- Measurement of the interpupillary distance
- Determination of the near point of convergence
- External examination
- Determination of ocular motility
- Tests for pupillary reactions
- Determination of tension digitally
- Ophthalmoscopic examination
- Retinoscopic examination
- Subjective refraction (frog test) with the use of Snellen charts  
and astigmatic charts
- Distance and near phoria test
- Cover test for phoria

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test 8 (sharpness of image) is always interpreted as a basis for referral. Marked divergence from the normal range with test 6 (lateral imbalance) is usually considered a basis for referral if the fusion tests have also resulted in failure. Some leeway should be allowed for the interpretation of exceptional cases in which referral might be made on the basis of the entire series of tests without following the foregoing criteria exactly.

A further statement from this experienced person is of interest in this connection, since it points to a common problem met by those who seek to get adequate ocular attention when school children are referred for attention: "When children are in a situation where it is likely they will be examined by a reliable practitioner making muscle and fusion tests, then all children failing any single test, with the exception of test 5 (stereopsis), should be referred. Those failing test 5 should be rechecked in six or eight weeks, because failure with this test may be a symptom of a disturbance in the ocular reflex which may show up at some later date." Retests for many of the children were recommended before the final decision was made regarding those needing a specialist's attention.

The criteria set up for determining the recommendations to accompany his reports are presented here in detail. After each examination was completed, one of the following notations was made: (1) no recommendation, (2) examination indicated, (3) examination if school work warrants<sup>6</sup> and (4) yearly check-up. These criteria are presented in detail as follows:

- |  |                               |
|--|-------------------------------|
| 1. Simple hyperopia                                |                               |
| Up to +1.00 D.                                     | No recommendation             |
| +1.00 to +2.00 D.                                  | Refer if school work warrants |
| +2.00 and up                                       | Examination indicated         |
| 2. Hyperopic astigmatism                           |                               |
| Up to +0.75 D.                                     | No recommendation             |
| +0.75 to +1.25 D.                                  | Refer if school work warrants |
| +1.25 D. and up                                    | Examination indicated         |
| 3. Compound hyperopic astigmatism                  |                               |
| Up to +1.00 D. sph. with up to +0.75 D. cyl.       | No recommendation             |
| +1.00 to +1.50 D. sph. with up to +0.75 D. cyl.    | Refer if school work warrants |
| +1.50 D. sph. and up with up to +0.75 D. cyl.      | Examination indicated         |
| Up to +1.00 D. sph. with +0.75 to +1.25 D. cyl.    | Refer if school work warrants |
| Over +1.00 D. sph. with over +1.25 D. cyl.         | Examination indicated         |
| 4. Simple myopia                                   |                               |
| With naked vision of less than 20/30 in either eye | Refer for examination         |
| 5. Simple myopic astigmatism                       |                               |
| With naked vision of 20/30 or less in either eye   | Refer for examination         |
| 6. Compound myopic astigmatism                     |                               |
| With naked vision of 20/30 or less in either eye   | Refer for examination         |
| 7. Mixed astigmatism                               |                               |
| With naked vision of 20/30 or less in either eye   | Refer for examination         |
| 8. Amblyopia                                       |                               |
| If vision is not improved to at least 20/30        | Refer for examination         |
| 9. Heterotropia                                    | Refer for examination         |

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6. This notation was made in cases of borderline errors in which referral was left to the discretion of school authorities in view of child's general condition of health and school success.

- |  |  |
|--|--|
| 10. Heterophoria in which                                |  |
| Exophoria exceeds 10 prism diop-<br>ters for near vision | } Refer for examination  |
| Esophoria exceeds 10 prism diop-<br>ters for distance    |  |
| Hyperphoria exceeds 0.5 prism di-<br>opters for distance |  |
| 11. Pathologic involvement                               | Refer for examination  |
| 12. History of diplopia                                  | Refer for examination  |
| 13. Borderline errors                                    | Recommend examination if school work<br>warrants   |
| 14. Borderline errors                                    | Refer for examination if the general<br>appearance of health seems to indicate<br>that the error would be less adequately<br>compensated for than in a more robust<br>person |
| 15. Wearing of glasses                                   | Recommend a yearly check-up  |

Because of the attendant difficulties in a public survey of this nature, no effort was made to examine the original 200 children with cycloplegia. In order to determine whether or not differences occur in the recommendations made by the staff examiner when he examines with and without the use of a cycloplegic, using procedures identical with those used for original children, a group of 25 separate children was examined with homatropine hydrobromide cycloplegia and without cycloplegia. In only 1 case was the recommendation different: Before the administration of the cycloplegic, a notation of "examination if school work warrants" had been made; afterward the recommendation was "examination indicated."

As a check of the examining ophthalmologist's consistency in examinations of the same child, he reexamined 25 children under favorable conditions within a month, usually without knowing that they had been examined before and always without reference to his first record. This recheck revealed no variation in any case greater than the limits of the criteria which had been set up.

As a check on the consistency of the telebinocular tests, when the tests are repeated the results of the two tests (administered by different persons but in each case the retest was made by the person who gave the first test) were compared. When scored according to the manual, these records show that although the time interval was as great as a year in almost one half of the cases, the conclusions reached concerning referral were the same in 81 per cent of the cases.



By way of summary before presenting our results, we may describe our populations and procedures as follows:

1. The subjects consisted of 200 children, 6 to 15 years of age. One hundred of these were handicapped in reading or were suspected of having visual difficulty; the other 100 were selected at random.

2. All subjects were tested twice with the Betts visual perception and sensation cards (the DB series) administered by examiners as competent as those advised by the manufacturer of the tests. Scores were obtained by following the prescribed manual of directions and also by reference to a scoring system devised by an expert from the instrument company.

3. The subjects were then examined by the ophthalmologist, who used a uniform procedure and made recommendations according to criteria previously set up.

TABLE 1.—*Percentage of Groups A and B Referred on the Basis of Ophthalmologist's Examination*

| Ophthalmologist's Recommendations  | Percentage of<br>Group A<br>(100 Children) | Percentage of<br>Group B<br>(100 Children) |
|------------------------------------|--|--|
| Refer* to an eye specialist.....   | 30   | 7  |
| Refer if school work warrants..... | 6  | 4  |
| Yearly check-up.....               | 11   | 6  |
| Total.....                         | 47   | 17   |
| Passed.....                        | 53   | 83   |

\* In this and the following tables "refer" means the ophthalmologist recommended that the subject needed further attention of an eye specialist; "passed," that he did not need such attention.

4. The findings of the ophthalmologist's examination in each case were tabulated to indicate whether or not the child should be referred to an eye specialist. Likewise, the results of the telebinocular tests were recorded to indicate which children had passed and which had not passed and should therefore be referred for ocular attention. A comparison of the findings from these two sources was then made. The results appear in the tables.

#### RESULTS OF STUDY

In general, the percentages of groups A and B referred on the basis of the ophthalmologist's examination correspond to findings in other surveys on vision. They suggest the rough limits to be expected of a testing instrument designed to sort out those children who should be referred to a specialist.

Before tables 2, 3, 4 and 5 are read, it should be noted that each of the 100 children had been tested twice with the telebinocular tests at an interval of about one year and once by the ophthalmologist at the time the second series of telebinocular tests was administered.

TABLE 2.—*Comparison of the Results of Two Administrations of the Telebinocular Tests Scored According to the Test Manual with the Results of the Ophthalmologist's Examination \**

|                                    | Results of Scoring Telebinocular Tests (Administered Twice) According to Manual † | Of This Number the Ophthalmologist |          |                                   |                         |
|------------------------------------|---|------------------------------------|----------|-----------------------------------|-------------------------|
|                                    |   | Passed                             | Referred | Referred if School Work Warranted | Advised Yearly Check-up |
| Passed by two series of tests....  | 3   | 0                                  | 3        | 0                                 | 0                       |
| Referred by two series of tests... | 78  | 38                                 | 26       | 5                                 | 9                       |
| Passed once; referred once.....    | 12  | 9                                  | 0        | 1                                 | 2                       |
| Questionable once; passed once..   | 4   | 4                                  | 0        | 0                                 | 0                       |
| Questionable once; referred once   | 3   | 2                                  | 1        | 0                                 | 0                       |
| Total.....                         | 100   | 53                                 | 30       | 6                                 | 11                      |

\* The subjects consisted of 100 school children, aged 9 to 15 years, handicapped in reading or suspected of having visual difficulty.

† The entire DB series of the Betts visual sensation and perception tests was used.

TABLE 3.—*Comparison of the Results of Two Administrations of the Telebinocular Tests Scored According to the Keystone Expert with the Results of the Ophthalmologist's Examination \**

|                                    | Results of Scoring Telebinocular Tests (Administered Twice) According to Keystone Expert | Of These the Ophthalmologist |          |                                   |                         |
|------------------------------------|--|------------------------------|----------|-----------------------------------|-------------------------|
|                                    |  | Passed                       | Referred | Referred if School Work Warranted | Advised Yearly Check-up |
| Passed by two series of tests....  | 19   | 14                           | 4        | 0                                 | 1                       |
| Referred by two series of tests... | 35   | 15                           | 14       | 2                                 | 4                       |
| Passed once; referred once.....    | 37   | 17                           | 11       | 4                                 | 5                       |
| Questionable once; passed once..   | 6  | 4                            | 1        | 0                                 | 1                       |
| Questionable once; referred once   | 3  | 3                            | 0        | 0                                 | 0                       |
| Total.....                         | 100  | 53                           | 30       | 6                                 | 11                      |

\* The subjects consisted of 100 school children, aged 9 to 15 years, handicapped in reading or suspected of having visual difficulty.

Each series of telebinocular tests was scored (1) according to the manual and (2) according to the expert, making a total of 400 scorings of 200 tests administered to 100 children.

Table 2 shows that of 100 selected children only 3 passed the telebinocular tests twice when the tests were scored according to the manual. These 3 were referred for examination by the ophthalmologist.

The remaining 97 either failed to pass the tests or their record was questionable on one or both of the times that telebinocular tests were administered. They were scored according to the manual. Of these 97, the ophthalmologist passed 52.

TABLE 4.—*Comparison of the Results of the Telebinocular Tests\* Scored According to the Test Manual with the Results of the Ophthalmologist's Examination †*

|                                  | Results of Scoring Telebinocular Tests According to Manual‡ | Of This Number the Ophthalmologist |          |                                   |                         |
|----------------------------------|---|------------------------------------|----------|-----------------------------------|-------------------------|
|                                  |   | Passed                             | Referred | Referred if School Work Warranted | Advised Yearly Check-up |
| Passed the tests.....            | 11  | 10                                 | 0        | 0                                 | 1                       |
| Referred by the tests.....       | 74  | 60                                 | 7        | 4                                 | 3                       |
| Questionable with the tests..... | 15  | 13                                 | 0        | 0                                 | 2                       |

\* These children were tested twice, but only one complete test record was available in most instances because of errors or omissions made by the teachers or nurses who gave the tests. These errors were made in spite of the fact that each teacher or nurse had been given the usual instruction in the use of the instrument and had followed directions given in the manual. Frequently test 8 (sharpness of image) was omitted or improperly recorded by the nurse or teacher. In such cases the missing data were obtained by a second examiner and the subtest scores combined to give a complete test record for each case.

† The subjects consisted of 100 school children, aged 6 to 15 years, selected at random.

‡ The entire DB series of the Betts visual sensation and perception tests.

TABLE 5.—*Comparison of the Results of the Telebinocular Tests\* Scored According to the Keystone Expert with the Results of the Ophthalmologist's Examination †*

|                                  | Results of Scoring Telebinocular Tests According to Keystone Expert | Of This Number the Ophthalmologist |          |                                   |                         |
|----------------------------------|---|------------------------------------|----------|-----------------------------------|-------------------------|
|                                  |   | Passed                             | Referred | Referred if School Work Warranted | Advised Yearly Check-up |
| Passed by the tests.....         | 45  | 41                                 | 0        | 2                                 | 2                       |
| Referred by the tests.....       | 55  | 42                                 | 7        | 2                                 | 4                       |
| Questionable with the tests..... | 0   | 0                                  | 0        | 0                                 | 0                       |

\* These children were tested twice, but only one complete test record was available in most instances because of errors or omissions made by the teachers or nurses who gave the tests. These errors were made in spite of the fact that each teacher or nurse had been given the usual instruction in the use of the instrument and had followed directions given in the manual. Frequently test 8 (sharpness of image) was omitted or improperly recorded by the nurse or teacher. In such cases the missing data were obtained by a second examiner and the subtest scores combined to give a complete test record for each case.

† The subjects consisted of 100 school children, aged 6 to 15 years, selected at random.

According to the Keystone expert, 19 passed the telebinocular tests twice (table 3). The remaining 81 either failed to pass the tests or their result was questionable with one or with both series of tests. The ophthalmologist passed 14 of the 19 and 29 of the 81.

Table 4 shows that of 100 children selected at random, 11 were passed according to the manual. Of these 11, 10 were passed by the ophthalmologist.

The remaining 89 were either referred or their results were questionable, according to the scoring procedure described in the manual. Of these 89, the ophthalmologist passed 73.

According to the Keystone expert, 45 passed the telebinocular tests (table 5). Of these 45, the ophthalmologist passed 41. The remaining 55 failed to pass the telebinocular tests, according to the Keystone expert. Of these 55, the ophthalmologist passed 42.

It can be seen that comparison of these findings indicates both qualitative and quantitative disparities. The study points to the fact that the telebinocular tests sort out too many children for practical purposes and also that they miss children who need to be referred for ocular attention. It answers in the negative the question posed at the beginning of our study: "Does the vision testing material as it is dispensed to and used by schools serve to screen out the children who should be referred to an eye specialist?"

Dr. Walter B. Lancaster gave advice and cooperation throughout this study.

# EXTRACTION OF SUBLUXATED LENS BY THE LEVER ACTION INTRACAPSULAR METHOD

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Extraction of a subluxated lens by the lever action intracapsular method is illustrated by the following case report.

*History.*—C. D., a Hindu woman aged about 55, came to me for relief of a subluxated cataractous lens of the left eye. She was fairly well nourished, and her general health was good. On examination the left eye was found to have a mature cataract which was partially subluxated downward and toward the nasal side. The pupil was triangular, with the apex of the triangle upward and toward the temporal side. There were posterior synechiae. The patient could not count fingers. There was perception of light when a beam was thrown, but a pupillary reaction was not present. The anterior chamber was shallow, and the subluxated lens and the superimposed iris were close to the posterior surface of the cornea.

For two years before the present examination the patient noted progressive diminution of vision in both eyes due to cataract formation. Gradually her vision was considerably diminished. However, she could walk in familiar pathways. Three months before the present examination a Mohammedan lens coucher offered to couch her cataracts. She agreed, and the coucher immediately attempted to couch the cataract in the left eye. He ultimately failed, and as a result there was much pain. He then turned his attention to the right eye. After a little while the couching of this eye was successful. The patient could see everything clearly with the right eye. The coucher applied a bandage and some medicine over both eyes. The patient remained in bed for ten days with the bandages on, as advised by the coucher. On the eleventh day she removed them. She could see everything with the right eye and had no trouble of any kind.

*Examination.*—On examination of the right eye, which had been successfully couched, it was found that the pupil was round and contracted properly to light. The media were clear, allowing a good view of the optic disk. The couched lens could be found. The point of puncture had thoroughly healed, so much so that its site could not be detected. From the condition of this eye I can fully corroborate Henry Smith's<sup>1</sup> observation that "in successful cases of couching, the cosmetic result is perfect; it is seldom equalled and never surpassed by any modern method of cataract operation." Indeed, the appearance of the eye was perfectly natural; there was no mark or scar left at the point of puncture. The visual result was also good (6/6), although the large cataractous lens which was lying in the deep lower region of the vitreous chamber was certain eventually to give rise to progressive atrophy of the optic nerve.

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1. Smith, H.: Treatment of Cataract, ed. 2, Calcutta, Butterworth & Co., Ltd., 1928, p. 205.

The left eye presented a large subluxated hard brown cataract with posterior synechiae. The cataract had been subluxated downward toward the nasal side during the unsuccessful attempt at couching. The iris was of a dull luster and was chronically inflamed. The cataractous lens could not be couched, owing to the posterior synechiae. On instillation of a 1 per cent solution of atropine several times, it was found that the pupil dilated in some places, though slightly, and became irregularly triangular. There was perception of light. The tension was slightly increased.

*Operation.*—The particulars of the process for extraction of the subluxated cataractous lens by lever action follow:

After the eyelids and face were antiseptically washed, 1.5 cc. of a 2 per cent solution of procaine hydrochloride was injected just above the left zygomatic arch for the purpose of blocking the branches of the left facial nerve supplying the orbicularis palpebrarum muscle.

A 4 per cent solution of cocaine hydrochloride was dropped into the conjunctival sac twice at an interval of five minutes. Then a 1 per cent solution of pontocaine hydrochloride and a solution of epinephrine hydrochloride were dropped into the conjunctival sac.

The patient was laid on the operation table. The right eye and the left ear were covered with cotton. An eye speculum was inserted under the eyelids of the left eye. The eye was washed thoroughly with sterilized water, and a 1 per cent solution of berberine sulfate was dropped into the conjunctival sac.

A limbic incision was made through about the upper half of the cornea with a Graefe's cataract knife. The corneal flap was to be terminated above the apex of the triangular pupil, which was located at about 3 minutes of the corneal dial. Therefore the puncture was made at 18 minutes of the corneal dial and included a small bit of conjunctiva. The point of the knife stuck at the anterior pole of the subluxated lens, which projected forward, and had to be steered a little upward before it could be passed across the anterior chamber. The point emerged at the counterpuncture at 40 minutes of the corneal dial. Then the incision was passed along the limbic arc and was terminated at 3 minutes of the corneal dial, with a small tongue of conjunctiva attached to the flap at its termination. The incision was thus a little less than a semicircle. The incision was therefore enlarged at the counterpuncture with scissors, so as to make it just one half of the circumference of the limbus.

Complete iridectomy was done with curved scissors. A bent spatula was passed between the posterior surface of the iris and the anterior capsule of the lens and turned all around. The adhesions between the iris and the lens capsule were thus broken, and the iris was freed completely. There was some hemorrhage from the cut and detached portions of the iris, which was controlled by a drop of a solution of epinephrine hydrochloride. The stirrup eyelid retractors were introduced under the lids and the speculum removed. This procedure is shown in the accompanying illustration.

The navicular socket fulcrum was placed at 3 minutes of the sclerocornea, engaging the upper equatorial border of the cataractous lens, which was a little below its usual position. Three nonviolent fish-angling jerks were all that were required to breach the zonule at about 33 minutes of the sclerocorneal dial, i. e., just at the diametrically opposite point to 3 minutes, where the navicular fulcrum

has been placed. The lower attachment of the zonule, which was stretched and partially ruptured during subluxation, easily gave way. The cataractous lens was rotated freely on the navicular fulcrum. The detachment of the zonule was completed by turning the lens over the hyaloid socket fulcrum with the bend of the mango leaf dislocator. The large cataractous lens was easily delivered on the temporal side by lever action. The corneal flap with the small conjunctival flap was placed in position with the spatula. The blood clots on the conjunctiva were wiped with pledgets of sterilized cotton. A drop of a 1 per cent solution of berberine sulfate was put into the conjunctival sac. Sterilized petrolatum was applied to the margins of the lids, and the lids were closed. A piece of lint boiled in a solution of extract of *Berberis asiatica* was placed over the closed lids, and both eyes were bandaged.

The cataractous lens in its capsule was examined and found to be hard and brown with a large nucleus and a thick capsule. The anterior capsule bore some black marks of synechiae. The eye was dressed on the fourth and seventh days with a 1 per cent solution of berberine sulfate. The postoperative period was uneventful. On the evening of the eleventh day the bandages were removed. The union of the corneal flap was found to be good and firm. There has been no relapse of the chronic iritis up to the time of writing, though suitable treatment must be continued to prevent it.

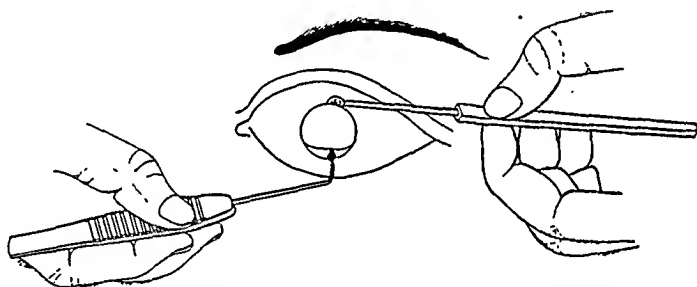


Diagram illustrating the delivery of a subluxated cataractous lens with posterior synechia by the lever action operation. The hyalonavicular fulcrum was applied at 3 minutes on the scleral lip of the incision, and the effort was given by the mango leaf dislocator at 33 minutes of the corneal dial from below upward and forward.

#### COMMENT

Extraction of a subluxated lens in which the lens is dislocated partially and the zonule is attached in some places can also be done safely and surely with the lever action intracapsular method. Thus, if any portion of the zonule is still attached, even though it is partially torn, and the zonule in other places is completely torn, the limbic incision should be so planned that the corneal flap terminates above and about the portion that is still untorn or partially attached. After such an incision is made, the navicular socket of the hyalonavicular fulcrum should be held fixed at about the termination of the incision on the scleral lip, so that the equator of the lens-in-capsule at the attached portion may be socketed within the navicular socket fulcrum, as, for example, if the zonule is partially attached at say 7 o'clock of the corneal dial of the left eye after a blow on that eye. Then the limbic incision

should terminate at 7 o'clock of the corneal dial. The puncture should be made at 4 o'clock and the counterpuncture at 10 o'clock of the corneal dial, thus making the incision cover exactly half of the lower limbic arc. The hyalonavicular fulcrum should be placed at 7 o'clock on the scleral lip of the incision, so as to socket the attached equator of the lens-in-capsule at 7 o'clock of the corneal dial within the navicular fulcrum. At the diametrically opposite point (in the example it is 1 o'clock, which is the diametrically opposite point of 7 o'clock) jerky efforts may be made with the tip of the mango leaf dislocator, if there are any attached fibers of the zonule. Otherwise, if the zonule at this point has been completely torn, then the tip and leaf span of the mango leaf dislocator may be insinuated from the surface of the cornea below and behind the equator of the lens-in-capsule at that diametrically opposite point (1 o'clock in the example). By lever action, the dislocated end of the lens-in-capsule (1 o'clock end in the example) is rotated with the lip and leaf span of the mango leaf dislocator on the hyalonavicular fulcrum, into which is socketed the attached end (the 7 o'clock end in the example). By the rotation, any attached portion of the lens-in-capsule up to the base of the operative wound (up to 4 o'clock and 10 o'clock in the example) is easily detached, and the lens-in-capsule puts its nose into the wound. The hyaloid socket fulcrum is now used to socket the anterior pole of the lens-in-capsule, and the bend of the mango leaf dislocator is hooked around below and behind the lens in its capsule. The attached portion of the lens in its capsule which was socketed into the hyalonavicular fulcrum (7 o'clock portion in the example) is now completely detached from the zonular attachment. The lens-in-capsule may thus be delivered, without any internal instrumentation and without disturbing the vitreous gel or the ciliary body.

In the present case iridectomy was indispensable in order to detach the adhesions between the iris and the anterior capsule. In cases in which there are no posterior synechiae, iridectomy is not required. The subluxated lens in its capsule may be safely and surely delivered through an intact iris. The pupillary margin of a free iris gradually dilates to allow the passage of the presenting part of the lens in its capsule as it is rotated by lever action, even if the iris is not previously dilated by the use of a mydriatic.

I am confident that all surgeons will find the dislocation, rotation and delivery of the subluxated lens in its capsule much easier and certainly safer with the hyalonavicular fulcrum and the mango leaf dislocator. It is reasonable that before trying the violent methods of delivery, such as piercing the capsule with a needle, simple discission, delivery by means of Daviel's spoon, as advised by Bride,<sup>2</sup> or transfixing

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2. Bride, T. M.: Case of Congenital Dislocation of the Lenses in Two Brothers, *Tr. Ophth. Soc. U. Kingdom* 45:927, 1925.



the sclera by double needle, as advised by Agnew<sup>3</sup> (the end results of which are not satisfactory), the nonviolent<sup>4</sup> method of delivery by lever action<sup>5</sup> with the hyalonavicular fulcrum<sup>6</sup> and the mango leaf dislocator acting from the outside should be attempted. If delivery can be thus performed, the end results will be free from inflammatory reactions and will be satisfactory. In case this attempt at nonviolent delivery fails, the more violent methods may be afterward tried as may be required.

Before concluding this report, I shall offer a word of explanation about the use of berberine sulfate and extract of *Berberis asiatica* for dressings. Berberine sulfate has long been successfully used by me as an antiseptic and antiphlogistic in desperate septic conditions, such as arise from tiger bites and bear bites. In such cases, I apply berberine sulfate externally as a lotion or on compresses as well as administer it by mouth and by hypodermic injection. Although my bacteriologist friends are still engaged in investigating its bactericidal action in vitro and in vivo and will take more time before they give their opinion, clinically my own findings in vivo have long established the unquestionable value of this preparation in controlling mixed septic infections and also in preventing sepsis.

Because of their decided nonirritant antiseptic and nonpoisonous antiphlogistic properties in vivo, the drugs of the berberine group are especially advantageous in cataract operations, as they serve as a prophylactic against sepsis and in controlling septic processes in many ocular diseases. I have reason to believe that any ophthalmic physician or surgeon who uses berberine preparations will not be disappointed, provided the condition for which they are employed is curable.

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3. Agnew, C. R.: An Operation with a Double Needle or Bident for Removal of a Crystalline Lens Dislocated into the Vitreous Chamber, *Tr. Am. Ophth. Soc.* **4**:69, 1885.

4. Dutt, K. C.: Role of Nonviolence in Lever Action Intracapsular Extraction of Cataract, *Arch. Ophth.* **21**:8 (Jan.) 1939.

5. Dutt, K. C.: Lever Action Operation for Intracapsular Extraction of Cataract, *Arch. Ophth.* **18**:897 (Dec.) 1937.

6. The hyalonavicular fulcrum and mango leaf dislocator may be obtained from Down Bros., Ltd., London.

# OCULAR REACTIONS TO DIPHTHEROID BACILLI

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In 1929 Marchesani<sup>1</sup> reported the results of experimental work done with a strain of *Bacillus subtilis* which he had isolated from the sympathogenic eye of a person with mild sympathetic ophthalmia. By repeated intraocular injections of this organism into one eye of a number of rabbits he produced choroiditis in the opposite eye. The lesion consisted of a focal accumulation of mononuclear cells in the choroid. He expressed the belief that the choroiditis thus produced was dependent on paired organ sensitivity of the two eyes which allowed the antigen to localize in the second eye. At a later date<sup>2</sup> he repeated these experiments with *Bacillus xerosis* and *Staphylococcus albus* and apparently obtained similar results. Iga<sup>3</sup> and von Szily<sup>4</sup> repeated these experiments with *B. subtilis* and showed that a similar metastatic choroiditis could be produced by repeated intravenous and intraorbital injections of this organism. They concluded that local ocular allergy was not necessary for the production of metastatic choroiditis in the fellow eye. Apparently the inflammatory reaction thus produced was devoid of the typical epithelioid and giant cells characteristic of the picture of sympathetic ophthalmia.

While Marchesani's interpretation of his findings was somewhat discounted, both he and his critics have shown that a metastatic non-specific choroiditis could be produced by repeated injections of common organisms. This work and its possible relation to allergic endophthalmitis and sympathetic ophthalmia made it appear worth while to perform somewhat similar experiments with diphtheroids isolated from the conjunctiva of normal eyes and from an eye with sympathetic ophthalmia.

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From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital.

1. Marchesani, O.: Die sympathische Ophthalmie im Lichte experimenteller Forschungen, *Arch. f. Augenh.* **100-101**:606, 1929.

2. Marchesani, O.: Zur Pathogenese der sympathischen Ophthalmie, in *Concilium ophthalmologicum*, The Hague, Netherlands, 1929, vol. 2, p. 531.

3. Iga, F.: Zur Frage der Sensibilisierung und der "Sympathischen Choroiditis" mit *Bac. subtilis*, *Klin. Monatsbl. f. Augenh.* **83**:195, 1929.

4. von Szily, A.: Die Rolle der Infektion, der Toxine und der Anaphylaxie bei der "sympathischen Ophthalmie" im Tierversuch, in *Concilium ophthalmologicum*, The Hague, Netherlands, 1929, vol. 2, 533.

## EXPERIMENT 1

In the process of culturing bacteria from the normal conjunctiva, a strain of diphtheroid bacillus was isolated which showed unusual cultural characteristics. It was similar to *B. xerosis* in that it fermented dextrose and saccharose; it differed from the latter in that it grew more rapidly on ordinary mediums and formed a heavy pellicle on hormone bouillon. It was nontoxic to rabbits and guinea pigs, even when injected subcutaneously and intravenously in large quantities. Injections in the vitreous of 0.1 cc. of a heavy suspension of this organism in physiologic solution of sodium chloride almost invariably produced a purulent inflammatory reaction in the eyes of rabbits. This strain is hereafter referred to as strain A. It was used in the following experiments:

*Group A.*—Fifteen normal rabbits were given four subcutaneous injections of 0.5 cc. of a four day beef broth culture of this organism at weekly intervals. Four weeks after the first injection each animal received intravenously an intoxicating dose consisting of 2 cc. of the same culture.

*Result.*—Neither general nor ocular reaction resulted from the intravenous injection of the organisms.

*Group B.*—Five rabbits were given four similar subcutaneous injections of the same culture mixed with approximately 10 mg. of freshly prepared bovine uveal tissue pigment. Four weeks later these animals received intravenously an intoxicating dose consisting of 2 cc. of the diphtheroid culture.

*Result.*—No general reaction was observed in these rabbits. Two rabbits showed ocular reactions; 1 reacted unilaterally and the other bilaterally.

One of these 2 rabbits (no. 38) showed immediately on the completion of the intravenous injection marked contraction of the pupil of the left eye. Within two hours this eye was congested, the aqueous ray was present and the pupil was irregular in outline. Within twenty-four hours several irregularly round, grayish areas of choroiditis were seen in the lower part of the fundus. There were cells and pigment granules floating in the aqueous. The globe was soft. This reaction continued for four days, gradually subsiding thereafter. Beginning annular vascularization of the cornea was evident on the fifth day, and fine deposits were observed on the corneal endothelium. This eye was enucleated on the twentieth day, at which time the aqueous ray was still mildly present. The right eye showed no reaction at any time.

Histologic examination of the left eye showed foci of mononuclear cells in the choroid, among which a few polymorphonuclear leukocytes could be seen. Clumps of pigment within monocytes were present in

the ciliary body and the stroma of the iris. Serum and a few monocytes loaded with pigment were present in the anterior chamber. The cornea showed vascularization. There were a few mononuclear cells in the cup of the nerve and in the vitreous. The retina was normal. The eye was free from any purulent inflammatory reaction.

The other rabbit (no. 37) showed a bilateral ocular reaction within three hours after the intoxicating injection: There were moderate pericorneal congestion and a mild aqueous ray in each eye. Within twenty-four hours, irregular grayish areas of choroiditis were observed in the right eye. The fundus of the left eye could not be seen; the anterior chamber was abolished, and the cornea was hazy.

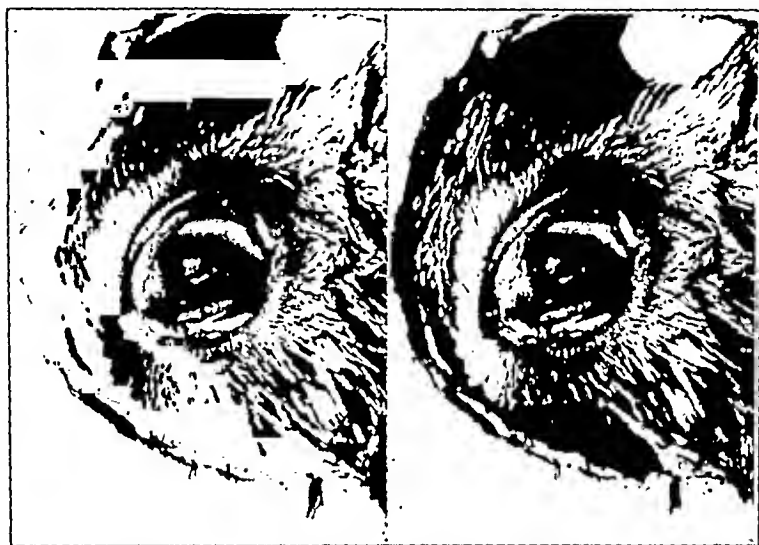


Fig. 1 (rabbit 37).—Ring abscess of the cornea of the left eye, which did not receive an injection, after an intravenous injection of a pathogenic strain of diphtheroid bacillus.

The reaction in the right eye continued at about the same level for four days, gradually subsiding thereafter; the eye was quiet on the twelfth day.

The reaction in the left eye progressed to panophthalmitis and ring abscess of the cornea within three days. Figure 1 shows the pathologic changes in this eye on the sixth day after the appearance of the reaction.

Both of these eyes were enucleated three weeks after the intoxicating injection. Bacterial cultures of the eyes proved negative.

Histologic examination of the right eye (fig. 2) showed a few small foci of mononuclear cells in the choroid. There were many large clumps of pigment within monocytic cells in the ciliary body. Other structures of the eye were normal.

The left eye (fig. 3) presented an abscess of the entire anterior segment and a typical ring abscess of the cornea. The retina was

replaced by connective tissue. The choroid was infiltrated throughout with mononuclear cells and presented several nodules consisting of mononuclear cells surrounding a vessel which contained few polymorphonuclear leukocytes. The globe was shrunken.

The reactions observed in these eyes were in all probability due to accidental lodging of the bacteria in the eye and should be regarded fundamentally as metastatic ophthalmia. On the other hand, the



Fig. 2 (rabbit 37).—Clumps of pigment in the ciliary body of the right eye, which did not receive an injection, after an intravenous injection of diphtheroid bacilli. Low power magnification.

peculiar reaction in the choroid with pigment phagocytosis by monocytes suggests that there may have been some ocular sensitization from the preceding injection of bacteria and pigment which influenced the pathologic picture.

*Group C.*—Five rabbits received one injection of 0.1 cc. of a heavy suspension of the diphtheroid bacilli in physiologic solution of sodium chloride in the vitreous of the right eye. The reaction in these eyes varied. Generally it was severe for

about five days, gradually subsiding during the next three weeks. Vascularization of the cornea occurred in 2 of the animals. Four weeks after the last sensitizing injection, each rabbit was given an intoxicating dose of 2 cc. of the culture intravenously.

*Result.*—No general reaction was observed in any of these animals.

Four rabbits showed a transient reaction in the right eye which lasted twenty-four hours. There was no reaction in the opposite eye.

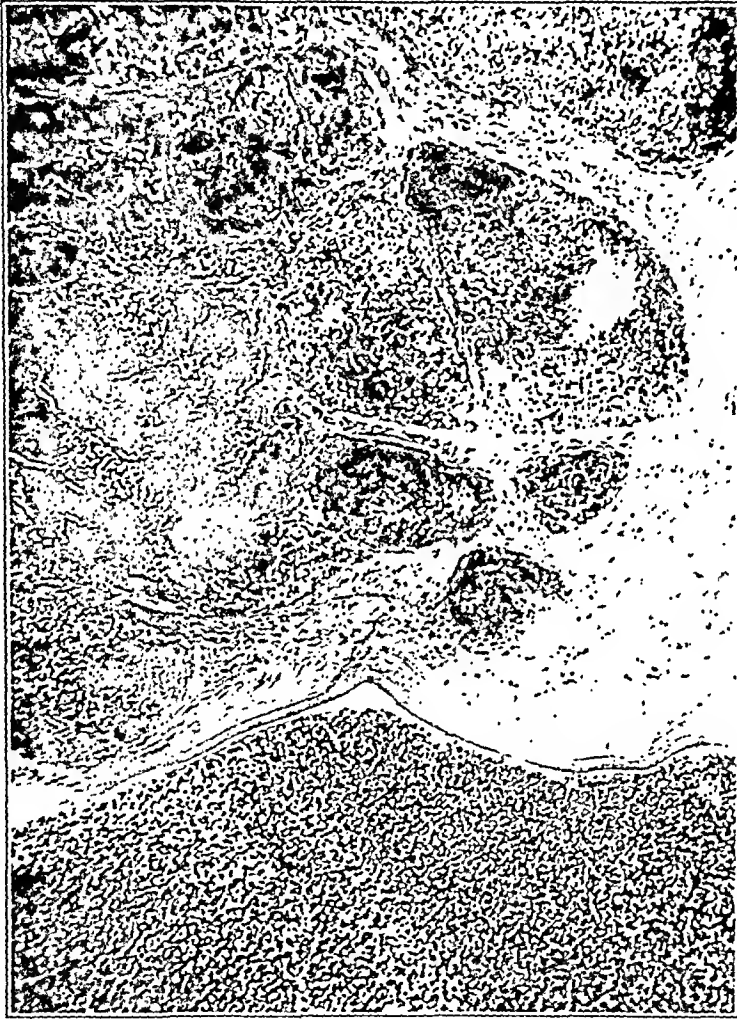


Fig. 3.—Histologic appearance of the left eye represented in figure 1. Low power magnification.

The right eyes of these four animals were removed at intervals ranging from four to six weeks after the ocular injection.

The histologic picture in these eyes varied somewhat, but the essential reaction was similar in all of them. The anterior chamber contained serum and a few polymorphonuclear leukocytes. There were many scattered clumps of pigment in the iris and the ciliary body. The vitreous showed a purulent reaction. There was an accumulation

of mononuclear and polymorphonuclear cells on the surface of the retina. The choroid showed foci of mononuclear cells throughout.

In 1 rabbit (no. 31) a bilateral ocular reaction developed within twenty-four hours. The right eye showed a more severe reaction than the left, but each eye was the seat of active inflammation. Irregular grayish areas of choroiditis were seen in the lower part of the fundus of the left eye. Free pigment granules were present in the aqueous of each eye. The activity in the eyes continued for about eight days, gradually subsiding during the next three days, when they were enucleated.

The inflammatory reaction seen in the right eye of this animal was similar to that observed in the other right eyes just described except that it was more intense throughout.

The left eye showed a focal infiltration of the choroid with mononuclear cells, some serum in the anterior chamber and many clumps of pigment in the ciliary body. There was no purulent reaction in the vitreous, and the retina was normal. This picture was similar to the one shown in figure 2.

While the number of animals in this experiment is manifestly too small to allow any definite conclusions, it appears that repeated subcutaneous injections of this strain of diphtheroid alone exerts no sensitizing power. When this organism is mixed with uveal tissue pigment and then injected subcutaneously, it is possible that the addition of the pigment may produce some especial sensitivity of the eye, although this is far from proved. When the organisms are injected directly into one eye the concentration then appears sufficient to exert a local antigenic effect, for intravenous injection later produces an ocular reaction. In 1 animal this sensitization was carried over to the opposite eye.

## EXPERIMENT 2

In the course of treatment of a patient with sympathetic ophthalmia complicated by secondary glaucoma, the opaque lens was removed from the sympathizing eye. The lens was immediately dropped in a large test tube containing broth which was incubated for twenty-four hours at 37 C. A pure growth of *Bacillus hoffmanni* developed. Although this organism was considered to be a contaminant, it seemed desirable to study its pathogenicity in normal rabbits and its antigenic properties in the eyes of properly sensitized animals. The organism is hereafter referred to as strain B.

*Sensitization of Rabbits.*—In an attempt to sensitize rabbits with diphtheroid antigens, it was discovered that repeated intracutaneous injections of pure cultures of strain A or B did not produce marked sensitization. Since good sensitizing results had previously been

obtained with the insoluble uveal pigment by the synergic action of staphylotoxin,<sup>5</sup> this method of sensitization was undertaken. Both strains were tried, but sensitization with strain A was found to be superior to that with strain B. It was also discovered that once allergy was established to the filtrate of one strain, sensitive animals reacted equally well to filtrates of other strains of diphtheroid bacilli. Sensitization was therefore undertaken by repeated injection with the "staphylo-diphtheroid" antigen, which was prepared as follows: A forty-eight hour beef hormone bouillon culture of strains A and B of diphtheroid bacilli was inoculated with a toxin-producing staphylococcus (strain Ha) and incubated for eight days at 37 C. according to Burky's technic.<sup>6</sup> Enough tricresol was added to make a 0.5 per cent solution, and the mixture was then placed in a shaking machine for twelve hours.

Sensitization was accomplished by four intracutaneous injections of the staphylo-diphtheroid antigen at intervals of one week. The criterion of sensitivity was based on the cutaneous reaction to an intracutaneous injection of 0.1 cc. of swine broth filtrate of *B. hoffmanni*. Twenty-four of 30 rabbits were thus sensitized.

*Normal Rabbits.*—Six normal rabbits were treated as follows: Two rabbits received one injection consisting of 0.1 cc. of a heavy suspension of *Bacillus hoffmanni* in physiologic solution of sodium chloride in the vitreous of each eye. Four rabbits received two similar injections fifteen days apart in one eye. The eyes into which the injections were made were enucleated two weeks after the last injection.

*Allergic Rabbits.*—Nine sensitized rabbits were divided into three equal sets (A, B and C) and treated as follows: Set A received one injection of the suspension of heat-killed bacilli in the vitreous of one eye. Set B received a similar injection of living bacilli. Set C received two injections of living bacilli fifteen days apart, one in the anterior chamber and one in the ciliary body or in the vitreous. These eyes were enucleated fifteen days after the last injection.

*Results.*—The histologic changes found in the eyes of the normal animals were similar in distribution but showed some difference in intensity. The most intense reaction was to be seen in the eyes which received two injections. In these eyes there were serum and few mononuclear and polymorphonuclear cells in the anterior chamber. A few mononuclear cells were present in the iris and the ciliary body. The vitreous contained some serum and a few mononuclear cells in front of the optic disk, in the zonular fibers and near the retina. The retina was not affected. The disk in some eyes was swollen, and there was

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5. Lucic, H.: Sensitization of Rabbits to Uveal Tissue by the Synergic Action of Staphylotoxin, *Arch. Ophth.* **22**:359 (Sept.) 1939.

6. Burky, E. L.: The Production in the Rabbit of Hypersensitive Reactions to Lens, Rabbit Muscle, and Low Ragweed Extract by the Action of Staphylococcus Toxin, *J. Allergy* **5**:466, 1934.



an accumulation of mononuclear cells in the cup. One eye showed infiltration of the optic nerve with mononuclear cells. A few small foci of mononuclear cells and dilated vessels were to be seen in the choroid of some eyes. No abscess formation was observed in these eyes.

The changes found in set A, B and C showed marked differences in intensity. The histologic picture varied from that observed in the eyes of the normal rabbits to a purulent reaction in the vitreous.

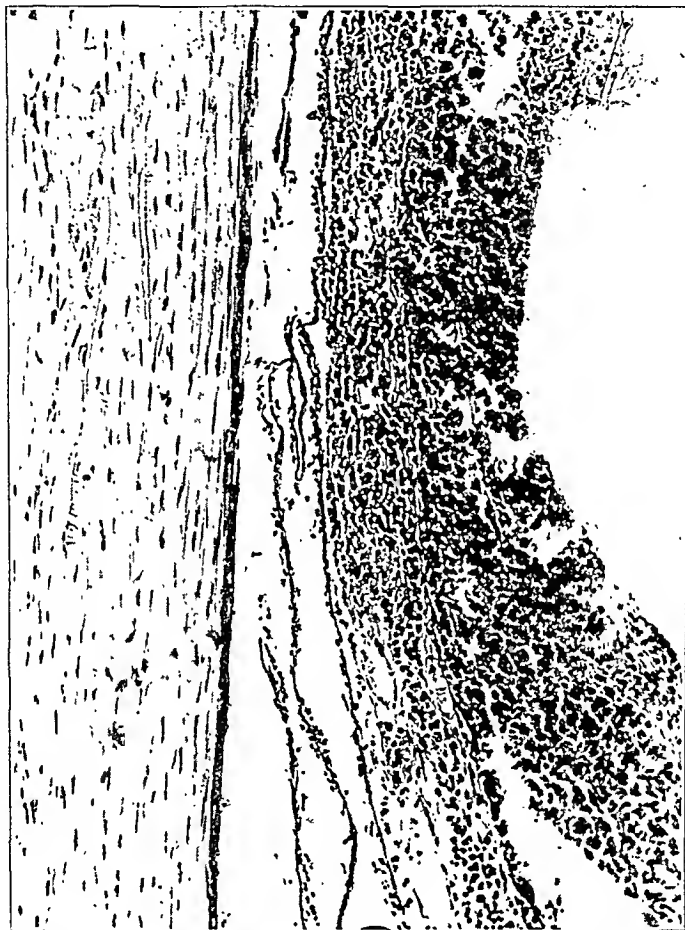


Fig. 4 (rabbit 69).—Infiltration of the choroid and retina with epithelioid cells showing pigment phagocytosis in a rabbit sensitized to the antigen of *Bacillus hoffmanni*. Low power magnification.

*Set A:* One eye showed no more reaction than that observed in the eyes of the normal animals. One eye showed a purulent endophthalmitis with many foci of mononuclear cells in the choroid. The third eye (rabbit 69) showed a lesion which is represented in figures 4 and 5. There was no purulent reaction observed in any part of this eye. The anterior chamber contained some serum and no cells. A few mononuclear cells were present in the iris, especially in the region of the

sphincter muscle. The ciliary body was free from any reaction. The vitreous contained some serum and few mononuclear cells in front of the optic disk. The choroid was essentially free from the inflammatory reaction except for an area of about 3 mm. in length near the equator. In this region the choroid was thickened and infiltrated with mononuclear cells, among which were seen several nests of epithelioid cells filled with fine pigment granules. The layer of pigment epithelium was



Fig. 5.—High power magnification of the section shown in figure 4.

destroyed in this region, so that the choroid and retina formed one continuous layer. The epithelioid cells in the retina contained more and larger granules of pigment than those in the choroid. The retina in other parts of the eye was normal.

*Set B:* One eye showed slightly more reaction than that seen in normal eyes. Another eye showed at the pupillary margin a large focus of epithelioid cells filled with pigment granules. A few other small but similar foci were seen in the choroid. There were few polymorphonuclear leukocytes in the ciliary body, but no purulent reaction

was present in the vitreous. The third eye showed a purulent reaction in the vitreous. The choroid was thickly infiltrated with mononuclear cells, among which there were a few epithelioid cells containing pigment granules.

*Set C:* Two eyes showed a diffuse infiltration of the iris with mononuclear, epithelioid and giant cells. The epithelioid cells were filled

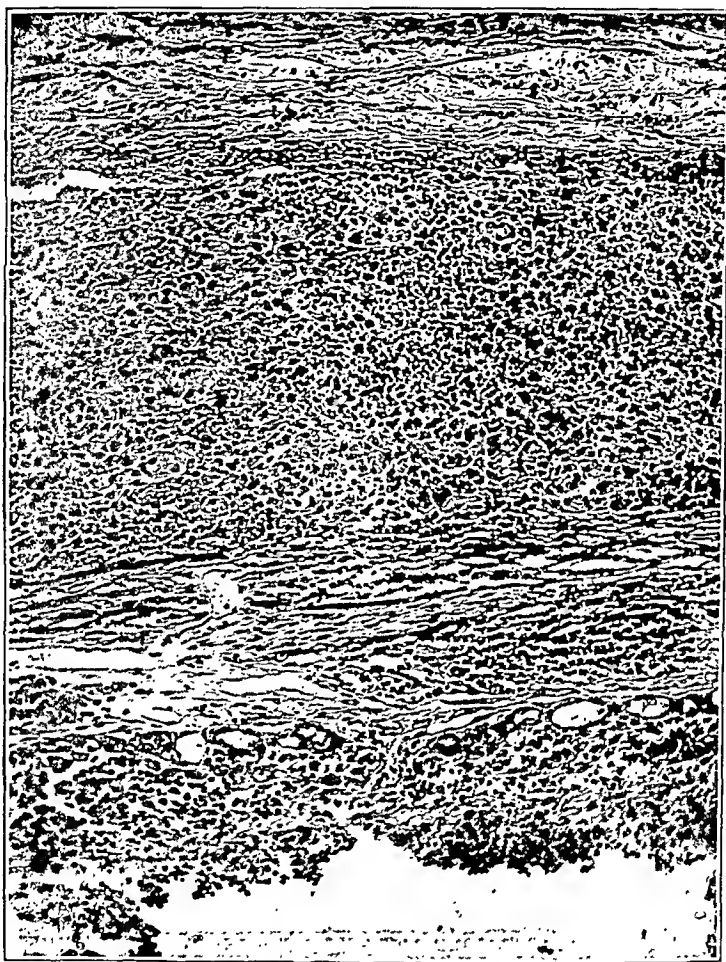


Fig. 6 (rabbit 7).—Infiltration of the choroid and retina with epithelioid and giant cells showing pigment phagocytosis in another sensitized rabbit. Low power magnification.

with fine pigment granules. The vitreous contained some serum and a few mononuclear cells, but there was no evidence of a purulent reaction. The choroid was essentially normal. The third eye (rabbit 7) showed a purulent reaction in the vitreous. The choroid was infiltrated with foci of mononuclear cells, and some areas were densely infiltrated with epithelioid and giant cells containing pigment granules. The retina also participated in this reaction (figs. 6 and 7).

This experiment shows that rabbits may be sensitized to diphtheroid antigen by the synergic action of staphylotoxin. When rabbits are so sensitized, the eyes of some of them participate in the resulting general hypersensitivity. In sensitized eyes the reaction may be elicited by killed or living bacilli, especially by repeated injections of these organisms.

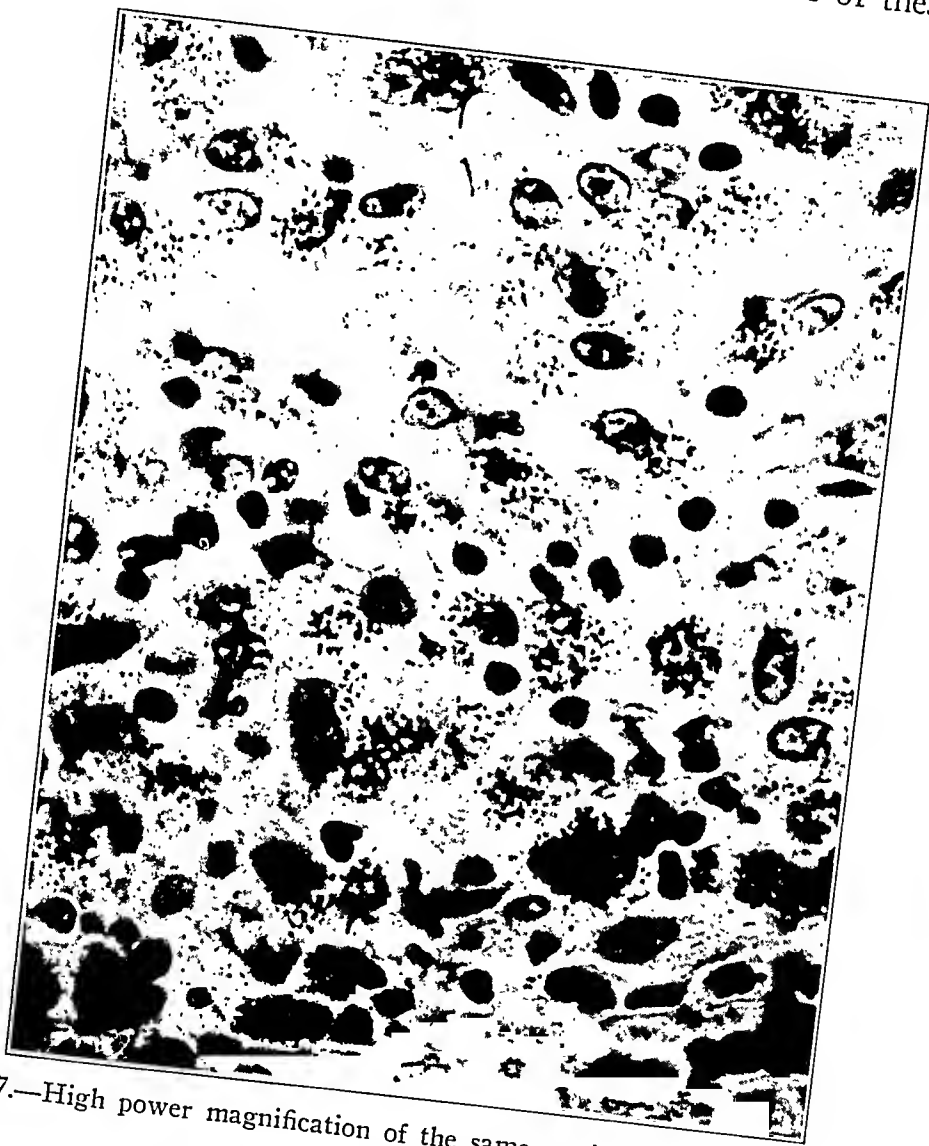


Fig. 7.—High power magnification of the same section shown in figure 6.

### EXPERIMENT 3

Fifteen rabbits which had previously been sensitized by repeated intracutaneous injections of staphylophtheroid antigen were given two injections of *Bacillus hoffmanni* in one eye, ten days apart. These injections consisted of 0.1 cc. of a heavy suspension of the bacillary culture in physiologic solution of sodium chloride; the first injection was given in the ciliary body and the second in the vitreous of the right eye.

The ocular reactions to the initial injection varied unpredictably. The second injection was invariably accompanied by a more severe reaction. It was usually most severe in the eyes which had shown a good reaction to the first injection.

Two weeks after the second intraocular injection each rabbit was given an intravenous injection of 2 cc. of the forty-eight hour broth culture of the same organism.

Six rabbits showed a mild reaction in the eye into which the injection had previously been made. Four rabbits (nos. 82, 87, 93 and 94) showed a moderate



Fig. 8 (rabbit 82).—Infiltration of the choroid and retina with epithelioid and giant cells showing pigment phagocytosis in the right eye, which had received an injection, of a sensitized rabbit. Low power magnification.

reaction in the right eye and a mild reaction in the left eye within four hours after receiving the intoxicating injection. These reactions cleared up within twenty-four hours.

A similar intravenous injection was given seven days later. The only significant reaction after this injection occurred in the 4 rabbits which had shown some reaction to the previous intravenous injection. The right eyes of these animals

reacted moderately, and the left eyes showed a transient reaction. The reaction was most severe in 1 of the animals (no. 82). In this rabbit areas of choroiditis and a positive aqueous ray developed in the left eye. The areas of choroiditis persisted, but the ray cleared up within forty-eight hours. The reaction in the right eye persisted for four days.

Six days later these 4 animals were given an injection in the left common carotid artery according to the technic described by Finnoff.<sup>7</sup> A coarse suspension of *B. hoffmanni* was prepared from a seventy-two hour blood agar culture for this purpose. Similar injections were given to 4 normal control rabbits.

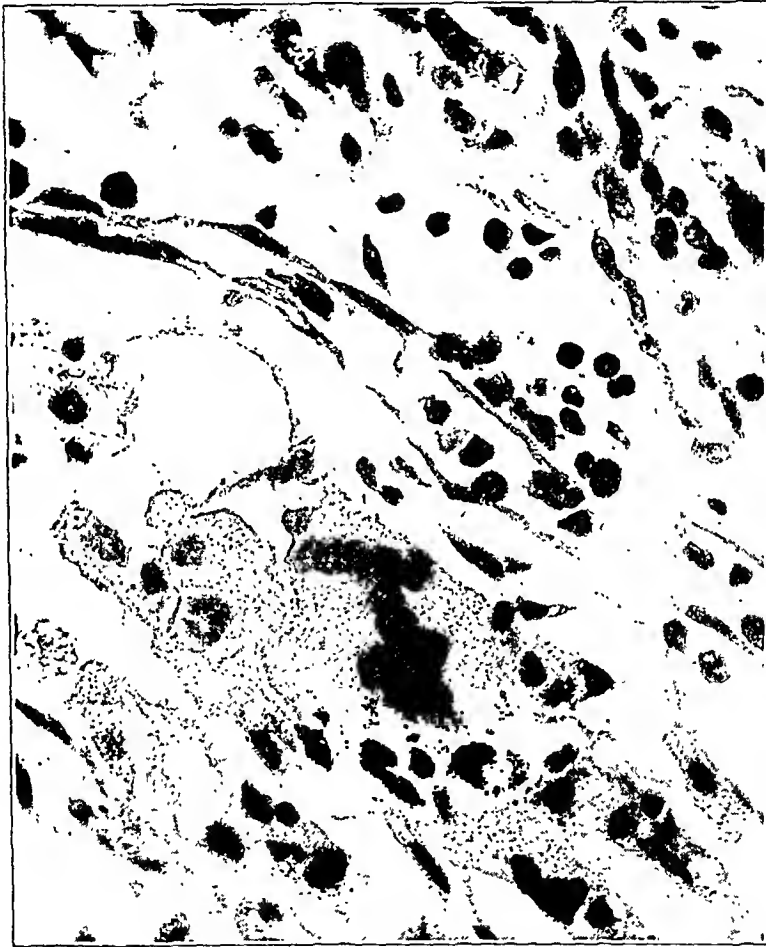


Fig. 9.—High power magnification of the section in figure 8.

*Results.*—The control rabbits showed no reaction.

Three of the rabbits showed a bilateral moderate reaction at the end of four hours. This reaction was more severe in the right than in the left eye. It consisted of a heavy aqueous ray and pericorneal congestion. No evidence of choroiditis was observed in the left eye. The reaction in the left eye persisted for twenty-four hours and in the right eye for approximately five days.

7. Finnoff, W. C.: A Technic for Producing Experimental Ocular Tuberculosis in Animals, *Tr. Am. Ophth. Soc.* 20:291, 1922.

The fourth rabbit (no. 82) showed a severe bilateral reaction within four hours, which was more marked in the right eye. This reaction consisted of severe pericorneal congestion, a heavy aqueous ray and congestion of the iris. The reaction in the left eye persisted for approximately twelve days, at which time the pupil was irregular; there were posterior synechiae and some fine deposits of pigment on the



Fig. 10 (rabbit 82).—Infiltration of the choroid with epithelioid cells showing pigment phagocytosis in the left eye, which had not received an injection. Low power magnification.

corneal endothelium and lens capsule. The reaction in the right eye persisted for two weeks, when the eyes were enucleated.

Histologic examination of the right eye of rabbit 94 showed only a few foci of mononuclear cells and a few giant cells in the choroid. This eye was otherwise normal.

The right eye of rabbit 93 showed some serum in the anterior chamber and serum with few mononuclear cells in the vitreous. The

choroid showed many foci of mononuclear cells and a few foci of epithelioid cells containing pigment granules. A few such foci of epithelioid cells were present in the ciliary body. There were no signs of a purulent reaction in any part of the eye.

The right eye of rabbit 87 showed a mild purulent infiltration in the vitreous. Both retina and choroid showed a moderate infiltration with foci of mononuclear cells. Epithelioid and giant cells loaded with



Fig. 11.—High power magnification of the same section shown in figure 10.

pigment granules were present in the choroid and in some areas of the retina.

The right eye of rabbit 82 showed an intense purulent reaction in the vitreous. The choroid and retina were densely infiltrated with foci of mononuclear cells, among which there were many epithelioid and giant cells loaded with pigment granules (figs. 8 and 9). There was no purulent reaction in any part of the opposite eye. The reaction was confined to the uveal tract and consisted of a mild infiltration of the choroid with mononuclear cells and a few areas of nodular infiltration



with epithelioid cells filled with pigment granules (figs. 10 and 11). The iris also showed a similar infiltration with mononuclear cells, among which were seen epithelioid cells, giant cells and monocytes containing a large amount of pigment.

The left eye of rabbit 82 was cultured immediately after enucleation, with negative results. Bacterial stains of sections of this eye showed no organisms.



Fig. 12.—Sympathetic ophthalmia in a human eye showing pigment phagocytosis by epithelioid and giant cells. Low power magnification.

#### CHARACTER OF OCULAR ALLERGIC REACTIONS

The histologic reactions which were observed in several of the eyes in these experiments resemble the reactions reported by Marchesani, Iga and von Szily in respect to the focal round cell infiltration of the choroid and the purulent reaction observed by them in the eyes. The reaction in the eyes which did not receive injections, which con-

sisted of an accumulation of mononuclear cells in the choroid, resembled the reaction obtained by these authors in similar eyes of animals and to the inflammatory picture observed by Friedenwald and Rones<sup>8</sup> in cases of "septic choroiditis" in man.

The picture produced by the presence of epithelioid and giant cells showing pigment phagocytosis, which is illustrated in figures 4 to 11, bears a striking resemblance to the picture seen in sympathetic ophthal-

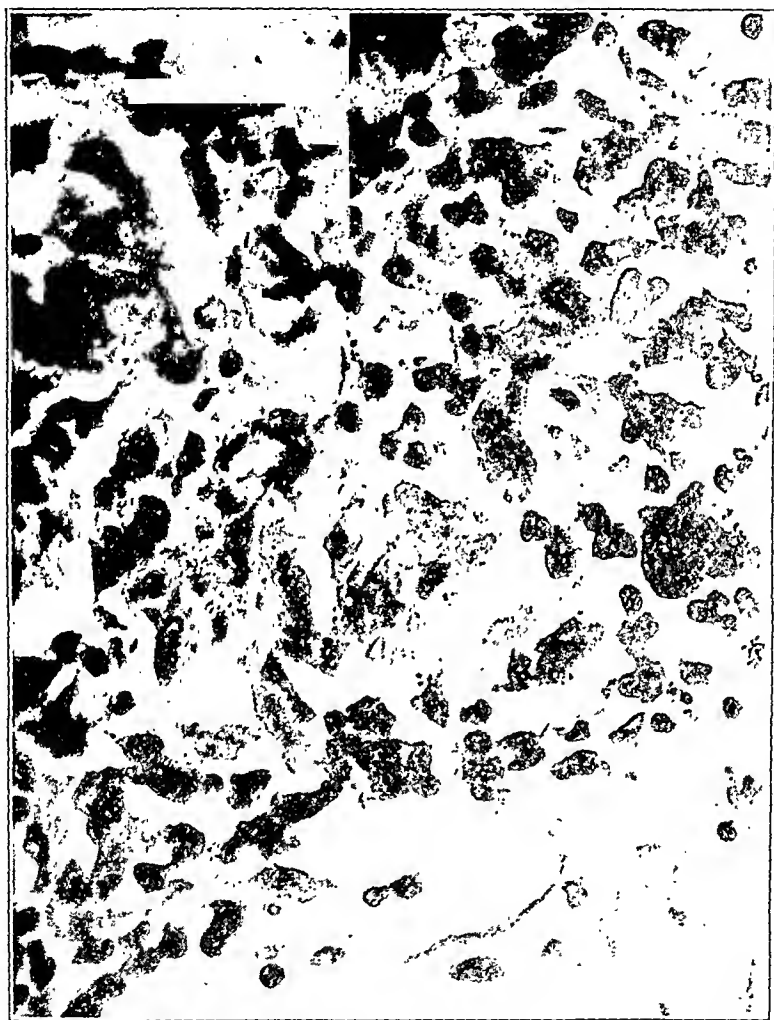


Fig. 13.—High power magnification of the same section shown in figure 12.

mia in man (figs. 12 and 13). The production of this picture in the eyes of experimental animals does not appear to have been previously reported.

#### GENERAL CONCLUSIONS

Diphtheroids obtained from the eye have insufficient antigenic value when used by themselves to evoke sensitivity or intoxication.

8. Friedenwald, J. S., and Rones, B.: Ocular Lesions in Septicemia, *Arch. Ophth.* 5:175 (Feb.) 1931.

When the diphtheroids are used in conjunction with uveal tissue their antigenic power may be enhanced, and there is some suggestive evidence that the addition of pigment may provoke some special sensitization of the eye.

When diphtheroids are used in conjunction with staphylotoxin a general sensitization results, and intoxication may be elicited in the eyes of a percentage of such animals either by local or by systemic injections of the diphtheroid antigen.

The histologic picture of the allergic reaction produced in the eyes, although in some animals complicated by a purulent reaction in the vitreous, consists of focal areas in the uveal tract. These areas show nests of epithelioid cells and pigment phagocytosis and have a striking resemblance to the histologic picture of sympathetic ophthalmia.

# DETECTING, MEASURING, PLOTTING AND INTERPRETING OCULAR DEVIATIONS

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The test most frequently used for detecting ocular deviations is the Maddox rod test. It is easy, speedy and apparently accurate, though in some cases its accuracy is only apparent. It is very accurate for measuring hyperphoria, but it often shows less exophoria and more esophoria than the more reliable cover test.

I have seen a patient with 8 prism diopters of exophoria show as much as 30 prism diopters of esophoria when tested with the Maddox rod. It is not uncommon for a patient to say that the line seen by the eye through the Maddox rod seems to be nearer than the light—not simply right or left or up or down or slanting. This impression of nearness tends to make the patient accommodate, especially if the tendency to accommodate is easily excited, as in the foregoing instance; then the associated tendency to convergence results in esophoria. If during this stage of esophoria (which may well be called spastic) the patient is asked to read letters at a distance, he can do so only when concave lenses are supplied, although if this is tried with the cover test he easily reads at 6 meters without a concave lens, or even with a weak convex lens, thus showing that the esophoria (convergence) is due to the active accommodation.

The reason for the superiority of the cover test is obvious if one considers the physiology of binocular fixation. An object attracts attention; the will decides to look at it (fixate it). The proper muscles are automatically innervated, some to contract and some to relax, to move the eye so that the image falls on the fovea. The innervation goes to the two eyes equally. If the movements are analyzed, it is found that the initial movement does not bring the fovea of each eye to the exact point. The result is imperfect fixation and diplopia—the two images are not exactly on corresponding points. Here another reflex, the fusion reflex, steps in and makes such further adjustments as are necessary to correct the diplopia and permit fusion so that binocular vision can be carried on. The purpose of the test for heterophoria is to see what position the eyes take under the influence of the first stimulus, that of fixation, without the action of the second, that of fusion. In this way it is possible to ascertain what the task of the fusion reflex is in a given

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case. The nearer the two eyes are moved to exact fixation by the fixation reflex, the less the fusion reflex has to do to complete the act.

Obviously the simplest and surest way to eliminate fusion is to cover one eye; then it cannot see and therefore cannot take part in fusion or binocular vision. At the same time the innervation required by the other eye for fixation is shared by the covered eye, because innervation treats the two eyes as a single organ and each eye has an equal share in the innervation.

Hence it is misleading to speak of the position of the covered eye as the "position of rest." The term implies that the innervation, and therefore the muscles of that eye, are relaxed—at rest. If it were possible to ascertain the position which the eye would take if its innervation, and therefore its muscles, were relaxed, it would not be helpful information, since the very essence of the problem is: When one eye is actively fixating, what does the other do? What position does it take if it is not prevented by fusion from deviating? What does the innervation excited by the effort of fixating by one eye do to the position of the other eye? The position it takes under cover is therefore the fusion-free position (Hofmann). I submit that this is a better term than the rather misleading one of "position of rest."

I wish to stress the point of view that looks on heterophoria as a real deviation rather than the point of view that regards it as a tendency to deviate. In heterophoria there is a real deviation provided the fusion stimulus is eliminated. If one eye is covered, the deviation promptly occurs and is a real deviation. Permit the stimuli involved in fusion to operate, and the deviation is compensated (corrected, made latent). It is important to think of the positions of the eyes as the result of a set or group of stimuli acting on them. The first stimulus is that of fixation. Its action can be shown with one eye. If one eye fixates, the innervation emanating from the stimulation of the retina of the fixating eye causes that eye to be rotated so that the object fixated is imaged on the fovea. But the innervation is never limited to one eye even when the other is covered. The covered eye also moves and takes a position, which, when coordination is perfect, places it in such a position that the image of the object would be found on the fovea if the cover were removed momentarily—both eyes are fixating the same point. Ordinarily coordination is not perfect, and a deviation occurs.

The second stimulus is that of fusion, which acts when both eyes are permitted to see the point of fixation.<sup>1</sup> Owing to this stimulus, any deviation of the eyes is promptly corrected, or compensated, so that the two images of the point are on the two foveas. Thus the essential feature of heterophoria is that the deviation is corrected when fusion operates.

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1. The periphery of the retina also shares in the fusion stimulus.

In heterotropia the fusion faculty, so-called, is unable to compensate or correct the deviation; the two images are not on corresponding points. If one eye fixates, its image is on the fovea but that of the other eye is not.

The weak point of the cover test is the difficulty of measuring the amount of deviation. Prisms of increasing strength are used until no movement of redress is apparent on removal of the cover. Then stronger prisms are used until a movement in the opposite direction shows an overcorrection on removal of the cover. The true deviation is about half way between these two limits. This is a time-consuming process, especially if several cardinal positions are included as they should be. It requires considerable skill and is not widely used, though it is highly recommended by prominent authorities.

Another method, the Graefe diplopia test, employs the phorometer. With this method, as used by Bielschowsky, the vertical prism is combined with a dark red glass and is used with a tangent scale in the form of a cross, as advised by Maddox. The patient sees the scale and center light with one eye, and with the other eye he sees the light as a red light but does not see the scale. He is asked where he sees the red light, i. e., opposite what number on the scale. At a measured distance from the scale, the numbers give the deviation accurately in degrees.

It often takes a little time and patience to teach the patient to use this test. He has to describe where he sees the red light; after a while most patients can do this fairly well. To interpret the findings, almost everything must be reversed. If the patient sees the red light to the right of the white one, it shows that the eye is deviated to the left and vice versa. If the prism is base up and he sees the red light farther down than the strength of the prism would throw it, it shows that his eye is deviating upward. This transposition is tricky and confusing until one is well trained concerning it.

#### RED-GREEN TEST

I wish to emphasize the accuracy of the cover test and also to stress its difficulties.

If some way could be devised to measure quickly and accurately the position of the covered eye when the other eye is fixating, whether in the primary position or in any of the cardinal positions, would it not be a valuable addition to the cover test, supplying its deficiency?

That is what my red-green test aims to do. The patient is seated before a white tangent screen in a darkened room, so dark that nothing is visible through the colored glasses. He is wearing red-green spectacles—red on the right eye and green on the left eye. With a red flashlight projector a red spot is thrown on the screen at zero on the scale, and the patient is told to look at it. He will fixate it with the right eye, which alone can see it. The left eye sees nothing and will deviate behind the

green glass, as under any form of the cover test. Suppose the patient has a deviation of 10 prism diopters outward (10 prism diopters of exophoria) and 2 prism diopters upward (2 prism diopters of left hyperphoria). That would be 5 arc degrees outward and 1 degree upward. With a green flashlight projector a green spot is thrown on the screen at that point, viz., 5 degrees to the left and 1 degree up. It will then be in such a position that its image will fall on the fovea of the left eye, since it has been assumed that the left eye is deviating that amount. It will be visible to the left eye, being green, but invisible to the right eye, which sees only the red, which is at zero. Where will the patient see the two spots, one red and one green?

The answer is easily given, based on the laws of binocular vision. According to Duke-Elder:<sup>2</sup>

The corresponding points, *par excellence*, are the fixation points (foveae). With the exception of certain cases of squint (anomalous projection) all objects imaged at the fovea are seen single.

Dittler<sup>3</sup> defined the law of identical points as follows:

Corresponding points of the two retinas are so related that all external points which are imaged on a pair of corresponding retinal points without exception appear in the same visual direction no matter where in space they really lie. . . . So far as directional value is concerned either fovea could serve without altering the sensation.

There is an exception not mentioned by Dittler. In certain cases of strabismus anomalous projection is developed. In these cases the image of the deviating eye when on a certain peripheral area of the retina (sometimes corresponding to the angle of squint) is projected to correspond with the fovea of the other eye. This is because the image of the point fixated by the normal eye has fallen on a peripheral spot of the retina of the squinting eye so often that a new habit is formed. Correspondence therefore is not an anatomic innate fixed attribute; it is not rigidly determined but is capable of development and of alteration (usually curable by orthoptics).

From this it is clear that the patient will see the red spot and the green spot in the same place superimposed on each other, although on the screen they are widely separated. Hence this separation on the screen is the measure of the deviation of the eye under cover.

#### METHOD OF USING RED-GREEN TEST

In practice, the green projector is placed in the hands of the patient. He is asked: Do you see the green spot on the screen? Do you see

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2. Duke-Elder, W. S.: *Textbook of Ophthalmology*, St. Louis, C. V. Mosby Company, 1933, vol. 1, p. 1029.

3. Dittler, R., in Schieck, F., and Brückner, A.: *Kurzes Handbuch der Ophthalmologie*, Berlin, Julius Springer, 1930, p. 415.

that you can move it anywhere you wish? He is then told to place the green spot on the red spot (which the examiner himself is projecting on the zero point of the screen). When he does this, he will place the green spot on the fixation point of the left eye—in the foregoing example 5 degrees to the left and 1 degree up.

Now the red spot can be shifted to any of the cardinal positions on the screen and the patient told to put the green spot on the red spot. A patient of average ability can do this almost instantly. It will be noticed, however, that in most cases there is a little shifting about or groping for the exact spot. If one could observe with a microscope the eye under cover in the cover test, he would find that the eye is not stationary. There is nothing to hold it stationary. Even the fixating eye is not stationary but is in constant motion about the point of fixation. The eye under cover owes its position to the innervation which is going to the fixating eye, which innervation it shares. When fusion is permitted, additional innervation comes into play which keeps the two eyes coordinated, both fixating the same point with sufficient exactness for practical purposes.

Thus the wavering fixation of the eye under the green glass is evidence of the soundness of the test. In cases of squint in which there is a central scotoma this inability to fixate precisely is conspicuous. It is often better for the examiner to hold both projectors. He places the red light on the zero and moves the other light in from the periphery. The patient is asked to tell on which side of the red light he sees the green light. He can tell as long as it is on the periphery. As it is moved nearer, he can tell that it is getting nearer. Suddenly he cannot tell where it is, but as the light is moved across to the other side he soon sees it again. He cannot see it when it is on the macula.

#### RED-GREEN TEST FOR SCOTOMAS

For this reason I have found an important collateral use of the red-green projectors with red-green spectacles in plotting scotomas. When a scotoma involves the fovea of one eye, about the only way to secure an accurate map is to use the other eye for fixation. If the scotoma is of the left eye, the right may be used for fixation by having the patient look through a tube large enough for him to see with the right eye the fixation point of the perimeter but not large enough for him to see the adjoining field, which it is desired to map. The Lloyd stereocampimeter offers an effective way of accomplishing the result. Another effective method is by the use of the red-green projectors. In case the left field is to be mapped, the patient, wearing red-green spectacles, fixates the red light held steadily at zero. The green light, visible only to the left eye, is then moved about, and the limits of any scotoma are mapped out quickly and accurately. For this purpose, a small round light is to be preferred



to the dash or line of light chosen for phorias and tropias. This form of light spot is obtained by changing the focus of the projector and holding it nearer the screen. The fact that the test object is colored (red or green) does not often interfere with good results, since the limits for color are the same as for white if the stimulus is strong enough. A small white test object gives the same size field as a larger, more intense red or green object. In some cases it does make a difference. For example, in a case of retrobulbar neuritis I found a larger scotoma with the green projector than with the Lloyd campimeter. Had the projector light been brighter and used at a shorter distance, the results of the two methods would doubtless have agreed more closely.

#### RED-GREEN TEST IN DIRECT READING

An important advantage of this test is that the results can be read directly. The positions do not have to be transposed and interpreted as is the case with diplopia tests with a single light. With this test, if the green spot is located to the left, the eye is deviating to the left. If it is to the right or up or down, the eye is deviating to the right or up or down. If the dash is tilted to the right, the corresponding eye is tilted in the same direction. Compare this with the complicated state of affairs with the diplopia test, in which if the two images appear to converge upward the vertical meridians of the eyes diverge upward, unless there is crossed diplopia; in this case the reversal must be reversed again, and the correct interpretation is that the vertical meridians of the eyes converge upward.

The astonishing simplicity of the new test is at first confusing, since the ophthalmologist is so accustomed to interpreting the false images of diplopia by reversing them that he finds it hard to realize that when the two foveas are being used there is no reversal but the results are read directly. Moreover, both objects being imaged on the foveas are as distinct as possible, whereas with the old diplopia test one object is on the fovea and the other is on the peripheral portion of the retina and thus is less vivid and distinct and harder to locate accurately.

#### RECORDING OR PLOTTING DEVIATIONS

It has been pointed out (Ohm) that recording of ocular deviations, especially in paralysis, has not been on the same plane of precision and accuracy as the recording of visual acuity or even of visual fields. This test will go far toward correcting that. However, it must be borne in mind that what is being measured is not such a fixed and exact thing as visual acuity or visual fields. The eye is in a mobile groping state in many cases when fusion is abolished, and it ranges over an area which may be several degrees in extent. If a test showed the position of the two eyes as fixed and definite and precise in cases of paralysis or paresis, it would excite doubt of its trustworthiness.

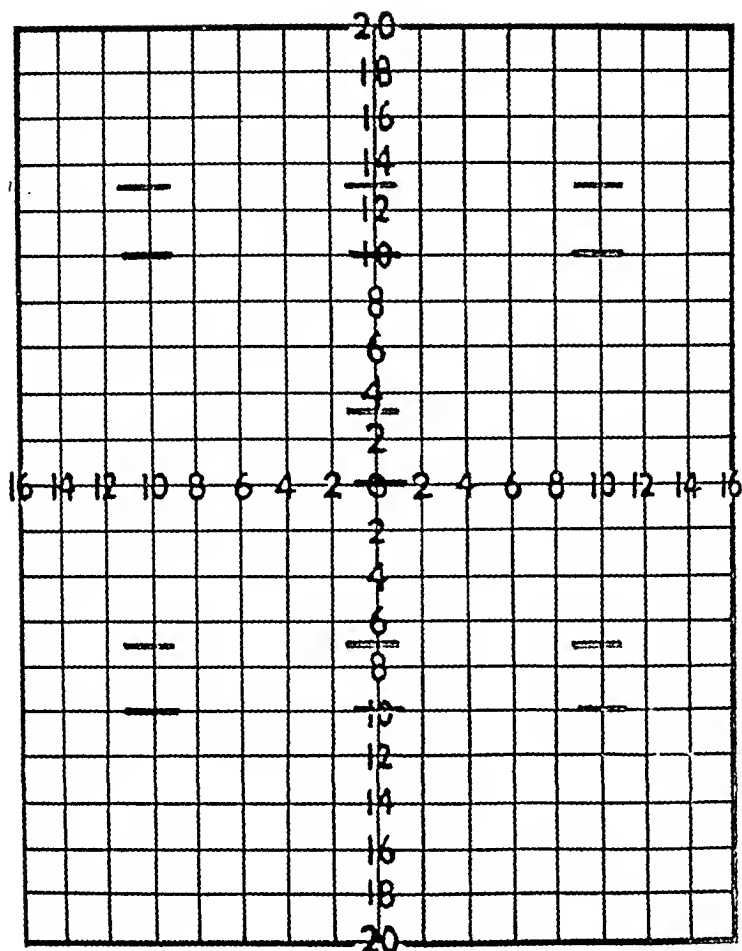


Chart 1.—Concomitant deviation in left hyperphoria

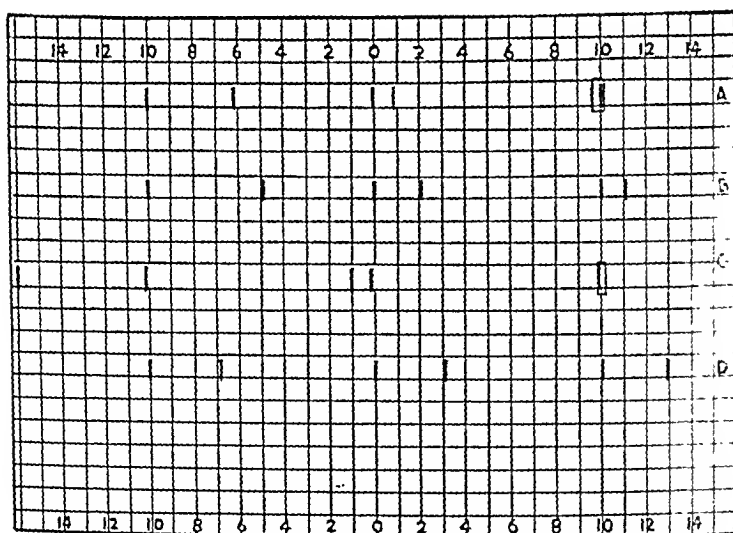


Chart 2.—Paresis of the left lateral rectus muscle. *A* shows the results of the test when the right eye is fixating. *B* shows the results when the right eye is fixating, but when there is a preexisting esophoria of  $2\frac{1}{2}$  prism diopters ( $1\frac{1}{4}$  degrees), which has to be added to each position and explains why the images are not superimposed to the right as in *A*. *C* shows the results when the left (paretic) eye is fixating. The deviations (secondary) are greater here where the patient looks to the left than in *A*. *D* shows the results of the test in the late stage of the paresis. The deviation has become concomitant. Only the history would make diagnosis possible.

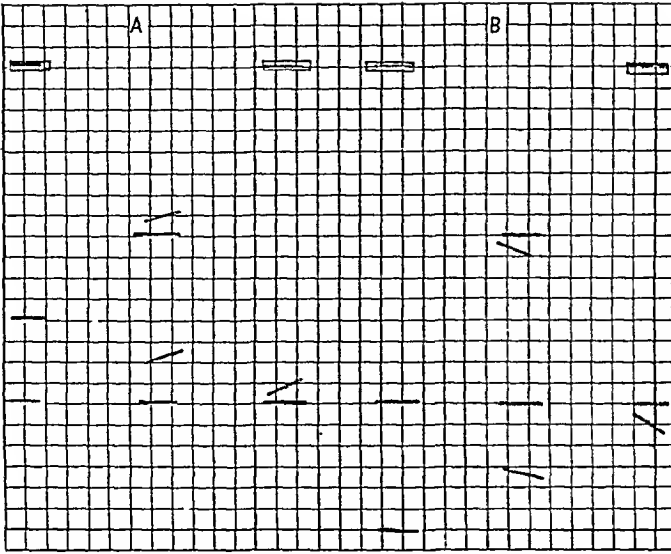


Chart 3.—Paresis of the left inferior rectus muscle. *A* shows the results of the test when the right eye is fixating. The left eye lags on looking down, especially to the left, and torsion is marked, down and to the right (adduction). *B* shows the results when the left eye is fixating. The deviation is greater when the paretic eye fixes.

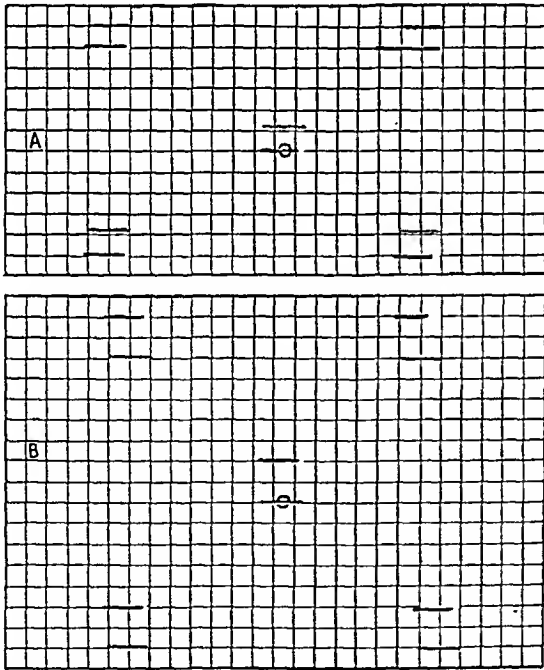


Chart 4.—Alternating hyperphoria. The nonfixating eye deviates up. *A* shows the results when the right eye is fixating, and *B*, when the left eye is fixating. The hyperphoria happens to be greater in this case when the left eye is fixating.

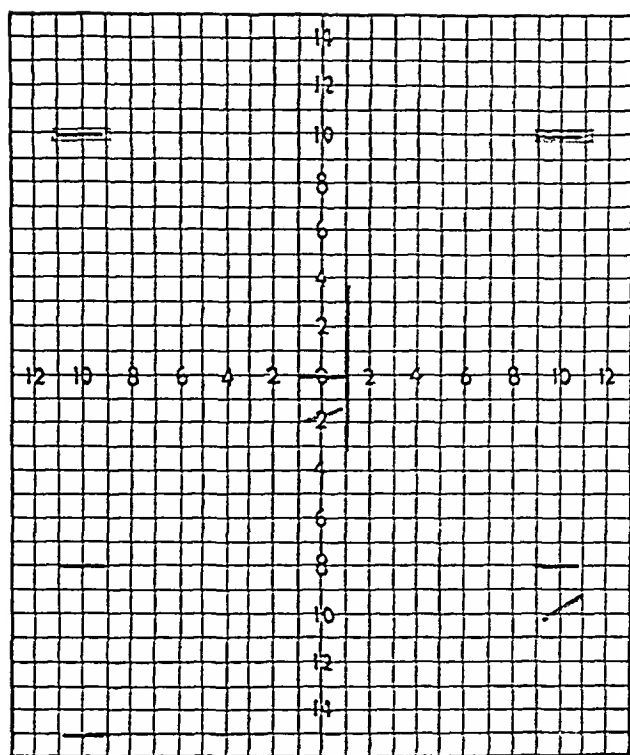


Chart 5.—Paresis of the right superior oblique muscle. There is no deviation upward. The maximum deviation is down and to the left and the right eye lags; the maximum torsion is down and to the right. The green dash is tilted, because when the red dash is held horizontally by the examiner the patient has to tilt the green dash to make it match the red one, as he sees the red dash with his paretic eye.

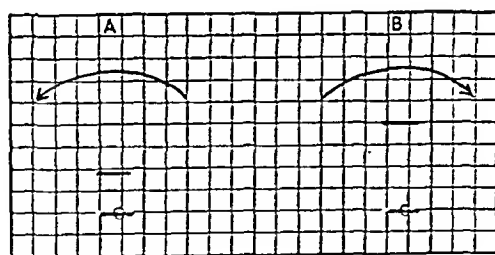


Chart 6.—Paresis of the right superior oblique muscle. The chart shows the effect of the postural reflex by way of the semicircular canals when the head is tilted: *A*, toward the left shoulder, and *B*, toward the right shoulder. The direction of the gaze is horizontal at zero, the left eye fixating. The right superior rectus and right superior oblique muscles are both called into action when the head is tilted to the right shoulder. Since the superior oblique muscle is paretic, the superior rectus muscle overwhelms it and pulls the right eye up. This test cannot be made when there is any horizontal deviation unless the Bielschowsky bite apparatus is used.



The tangent screen is a white window shade which rolls up when not in use. On it are drawn vertical and horizontal lines 7 cm. apart, forming squares. At the distance of 2 meters each square subtends 2 degrees (4 prism diopters); therefore, at 1 meter it subtends 4 degrees and at 4 meters, 1 degree. The room is not so dark that the examiner cannot see the squares and read the figures which are printed on the screen to facilitate recording.

Mathematically, a checker board, every point of which was at an equal distance from the eye, would form a spherical surface with the eye at the center, and on it each square would have equal angular value. When this is projected on a plane surface, the lines become curved, convex toward the center. This form of screen was chosen by W. R. Hess. He worked at a distance of 0.5 meter from the screen. At a distance of 2 meters or more the rectangular squares are sufficiently accurate.

Using a card which is a miniature reproduction of the screen, one can mark the positions of the red and green dashes with a red and green pencil. An assistant can do this and save time. It facilitates the recording if one follows a certain routine: vertical dash at zero, then right, then left; horizontal dash at zero, up to the right, up to the left, down to the left, and down to the right. The red projector is then given to the patient, and the test is repeated in all the cardinal positions.

Lastly, if there is no horizontal deviation of more than 2 or 3 degrees, one can take the readings with the patient's head tilted far toward the right shoulder and then toward the left shoulder. As the examiner stands beside the patient, it is easy for him to place his hand on the patient's head and guide this tilting. If there is a horizontal deviation, the head tilting produces a pseudo-vertical deviation, and the test can be made only with the bite apparatus of Bielschowsky, which makes the screen tilt with the head and so permits the posture reflex via the semicircular canals to act on the muscles which tilt the eyes without this pseudo-vertical or horizontal effect being observed.

When it is desired to test the positions with the eyes rotated farther to the right or left or up or down than the screen provides, one can turn the patient's head in the opposite direction, to the left, right, down or up, and so get a much larger range. The limit is the extent of the red-green spectacles. As soon as the patient sees around the edge of the spectacles he sees both red and green spots with the same eye (or even with both eyes) and promptly superposes them on the screen. The nose prevents the patient from looking far to the side, and the brow and lids prevent him from looking far up. However, it is rare that tests should be made in extreme rotations, because the findings are likely to be misleading, being influenced by idiosyncrasies in the anatomic details of the muscles and orbits.

An instructive example of the influence of the check ligaments in modifying the picture is seen in paresis of an abducens nerve, say of the left. When the patient looks to the left, the left eye lags; it lags more and more as the patient looks more to the left. If he is made to fixate with the left eye (the examiner holding the green projector) and to look toward the left, the right eye overshoots the mark, making a greater deviation of the eyes than when the nonparalyzed eye was fixating (secondary deviation). At first the deviation increases steadily and continuously as the eyes turn more and more in the direction of the paretic muscle—toward the left. Presently as the eye is made to rotate still farther the deviation ceases to increase and then actually decreases. Since the nonparalyzed eye has reached the limit of its possible excursion in that direction because it is arrested by the check ligaments, further effort produces no further movement. Not so with the paretic eye. Added effort succeeds in squeezing out a little more movement, and the left eye, not having yet reached its check ligaments, is able to move farther and so reduce the difference between the two eyes. This ability under vigorous effort to achieve additional rotation in the direction of the paretic muscle is the reason why it is often impossible to detect by direct inspection a limitation of movement in an eye in the direction of the weakened muscle, the weakness being compensated for by extra effort. Of course a completely paralyzed muscle does not show this phenomenon.

#### RED-GREEN TEST FOR CONCOMITANCE

One of the advantages of this test is the speed and accuracy with which one can determine whether a deviation is concomitant or not. If it is a horizontal deviation, the red dash is held at zero and then to the right and then to the left. One sees at a glance whether the deviation is the same. If it is a vertical deviation, besides the zero position one tries the up, down, up right, up left, down right and down left positions and easily demonstrates any difference in the deviation.

The reason the test for comitance is so important is that it shows whether or not there is a "weak muscle"—a paretic one. If there is, then the deviation is not concomitant but increases when the eyes are moved in a direction calling for positive action of the weak muscle and diminishes when the eyes move away from that direction in the direction which calls for relaxation (according to the laws of reciprocal innervation).

Forty years ago when I believed, as was generally taught, that a heterophoria was due to a weakness of some muscle, I thought that a weakness of an upward or downward mover could be elucidated by showing whether the vertical deviation was greater in adduction (oblique muscles) or abduction (rectus muscles). I was disappointed to find that the deviation was practically always the same, not changing whether

the eye was in the sphere of action of the oblique or of the rectus muscles. It was concomitant.

Even when a deviation starts as a paralytic deviation (noncomitant) there is a strong tendency for it to become comitant in time, after the paresis is healed. This is an important feature of the physiology, or the pathologic physiology, of ocular motility. The seat of the final trouble is no longer peripheral even if it was definitely so at first. One must think of the supranuclear portion of the neuromuscular mechanism as now dominating the action. Instead of an isolated muscle, it is a coordinated movement that is pathologic. Defects of coordinated movement are a sure sign that the coordinating mechanism is involved. This is always supranuclear, because it is a mechanism which selects which of the nuclei are to be made use of to accomplish a movement requiring the coordination, the simultaneous action in contracting or relaxing, of several muscles.

Tilting of the lines projected on the screen is easily demonstrated with most patients if it is present. I have not added any device for measuring the angle of tilting. It is not of sufficient importance.

#### INTERPRETATION OF DEVIATIONS

The first thing to determine is whether the deviation is concomitant or not. This is done more quickly and surely by this test than any other. The examiner holds the fixing light at zero (red or green according to which eye he wishes to be the fixing eye) and then at the various cardinal points and quickly sees whether the deviation as shown by the green light held by the patient is approximately the same in all or whether there is a definite increase in a certain part of the field of fixation.

In paralytic deviations the deviation increases when the eyes are made to look in the direction which calls for action by the paretic muscle. The fixation point (visual axis) of the eye lags behind that of the non-paralyzed eye. When diplopia is being tested by both eyes seeing one light and seeing it double, the diplopia increases in the field of action of the paretic muscle and the images get farther apart, but the image of the paretic eye overshoots that of the nonparetic eye, although the eye itself lags behind. This, of course, is because the false image is on the periphery of the retina and so its position is inverted, i. e., if the eye is to the right the image is to the left. With the red-green test, no inverting or reversal takes place. Both lights are imaged on the foveas of the respective eyes. If the eye deviates to the right, its light spot will be projected to the right.

It is not to be expected in concomitant deviations that exact equality of deviation will be found in all positions. Usually there are slight but detectable differences. The point is that there is no definite difference corresponding to the definite action of a definite muscle. The differ-



ences are more on a par with the groping differences in fixation when fusion is eliminated.

#### PARALYTIC DEVIATIONS

When it is made clear that the deviation is not comitant, the next step is to determine what muscle or what direction of movement is affected.

For horizontal deviations, it is easy to see that if a right mover is paretic, when the eye looks to the right the affected eye will lag, while when it looks to the left the deviation will disappear or become much less, because there will be no lag or much less lag. To tell which eye is affected requires no complicated interpretation; if the right eye is affected the red light lags; if the left eye is affected the green light lags.

Vertical deviations naturally give more trouble to the average ophthalmologist, yet the differentiation in typical cases is easy.

First upward rotation is tested to see whether an elevator is at fault. If it is, one or the other eye will lag on looking up. The eye that lags is the affected eye. Then downward rotation is tested to see whether a depressor is at fault. If it is, one or the other eye will lag on looking down. The eye that lags is the affected eye.

Next one determines which of the two elevators (or depressors) of the eye is at fault. To do this the deviation up to the right and up to the left is tested. Since the axes of the orbits diverge, so do the superior rectus muscles which are parallel to their orbital axes; therefore, each acts as an elevator chiefly when its eye is rotated outward (abduction). The same is true of the inferior rectus muscles, since they arise at the apex of the orbits and extend forward and outward parallel to the axis of the orbit to be inserted below the cornea, as the superior rectus muscles are above the cornea. Their major sphere of action is elevating or depressing the eye when it is abducted.

On the other hand, the oblique muscles have their major sphere of vertical action when the eye is in adduction. This is because their plane of action is from forward and inward in a direction backward and outward. When the eye is rotated nasally, the oblique muscles do the elevating and depressing. When the eye is rotated temporally, they do little but cause torsion.

Thus if an elevator of the left eye is at fault, the deviation will be greater up to the left if the superior rectus muscle is paretic but greater up to the right if the inferior oblique muscle (the other elevator) is at fault. If the deviation is the same, then the fault is not with an individual muscle.

Whether there is a convergent or divergent deviation added to the vertical deviation is of no importance in deciding which elevator (or depressor) is at fault, because any esophoria or exophoria present by

chance before the paralysis occurs will mask the slight inherent tendency of the elevator or depressor to produce some horizontal rotation.

The tilting which results from paralysis of an elevator or depressor is easy to demonstrate with the red-green test. It is occasionally of importance in the diagnosis. The vertical muscles which are attached to the upper part of the eye, the superior rectus and superior oblique muscles, act as inward rollers, causing intorsion, or conclination, when active and disclination, or outward torsion, when parietic.

The vertical muscles which act on the lower part of the eye (inferior oblique and inferior rectus muscles) act as outward rollers (top of vertical meridian tilted out) ; therefore, when either one is parietic the eyeball lags and its vertical meridian deviates inward (intorsion or conclination).

#### EFFECT OF HEAD TILTING

When the head is tilted to the right shoulder the eyes normally are given torsion to the left and vice versa. If one of the left rollers of the right eye (the two superior muscles) is weak, when these two muscles are called on for action by tilting the head only one responds. Suppose the superior oblique muscle is weak, then the superior rectus muscle acts alone. It produces a moderate intorsion as required but also an uncalled for upward rotation of the eye. If the superior oblique muscle were acting normally, it would balance this upward rotation by its downward rotating action. There would be good intorsion but no downward or upward rotation. Increased vertical deviation is the pathogonomonic symptom, not, as might be expected, a torsion.

On the other hand, if the superior rectus muscle were weak, the superior oblique muscle would be unopposed by its normal antagonist in this field and so would rotate the eye downward as well as intort the vertical meridian. These effects of head tilting can be demonstrated by the red-green test only when there is no complicating horizontal deviation. The only safe way is with the Hofmann-Bielschowsky bite apparatus, which avoids this pitfall.

Briefly, head tilt to the left calls for action of the left superior rectus muscle and the left superior oblique muscle. If the left superior oblique muscle is weak, the eye goes up, since the left superior rectus muscle is not balanced by the left superior oblique muscle. The posture assumed is head tilt to the right, because then the left superior oblique muscle is not in action and so its weakness is not felt.

A few examples of what may be expected in several types of deviation will illustrate some of the principles involved.

Chart 1 illustrates what may occur in a case of paresis of the left abducens nerve, typical of paresis of one of the horizontal muscles.

1. There may be esotropia in the primary position, esotropia increasing to the left and esotropia diminishing to orthophoria to the right.
2. When the left eye fixes, the secondary deviation is seen to produce an esotropia much greater to the left than when the right eye fixes.

3. The same deviations may occur as in 1, but in a case of esophoria of 4 prism diopters before the onset of the paralysis the esophoria is added to the esotropia in all positions.

4. There may be beginning secondary contraction of the antagonist. There is less difference in the amount of esotropia when the eyes look to the right and left.

5. In the late stage the deviation becomes concomitant. The paralysis which started the deviation can be diagnosed only by the history.

The deviation which follows a paresis, the actual rotation of the eye away from the affected muscle, must be due to the action of the antagonists. The tonic contraction is no longer balanced, but the non-paralyzed muscles outpull the paralyzed muscles, causing the deviation. In recent cases the amount of deviation produced by the tonus of the antagonist is affected by the general body tonus. A general neurologic examination will show increased tonus in some cases (active reflexes) and diminished tonus in others, and the deviation in the eye will be greater or less accordingly (Bielschowsky).

#### SECONDARY CONTRACTURES MAY OR MAY NOT OCCUR

When a muscle is innervated to contract, its antagonist is by the same act innervated to relax. If the paralysis of the given muscle (e. g., the left lateral rectus muscle) is due to a lesion of the sixth nerve, this lesion will interfere with the action of the lateral rectus muscle but not with the relaxation of the antagonist which is innervated through the third nerve. But if the lesion is higher up, it may, and often does, not only involve the active contraction of the agonist but also interfere with the relaxation of the antagonist. The result is that this muscle or muscles, not being relaxed from time to time, as was the case under normal conditions, becomes more and more contracted and a secondary contracture occurs (not to be confused with secondary deviation, which is the deviation when the paralyzed eye is used to fixate, the primary deviation being when the nonparalyzed eye fixates).

If this goes on a long time, the structural anatomic conditions are changed, so that even when the muscle relaxes it is not able to extend to its former length, nor can it be pulled out by considerable force. For example, in operating in such cases resection of the paralyzed muscle is by no means enough. The contracted muscle must be tenotomized and moved back.

It must be borne in mind that every muscle has in addition to its chief (typical) activity various subsidiary more or less unimportant actions. If, for example, a lateral rectus muscle happened to be attached more above the horizontal meridian (or below) than normal, it might produce slight vertical and torsional deviations. These should not be allowed to confuse the examiner, since they are always minor and never follow the plain rules of the action of the muscles they seem to imitate.

The superior and inferior rectus muscles, on account of the angle at which they are inserted into the eye, have a tendency to produce adduction, but this subsidiary action is of no importance in making a diagnosis of which vertical muscle is at fault, because a preexisting esophoria or exophoria would entirely mask it. The same is true of the oblique muscles as subsidiary abductors. The contribution that could be made by analysis of these subsidiary actions would be in aiding one to ferret out a preexisting esophoria or exophoria.

#### SUPERIOR OBLIQUE MUSCLE

The superior oblique muscle is a vertical mover, and it is easy in a typical case to tell which of the two depressors or which of the two elevators is affected, since the oblique muscles show their effect when the eye is adducted, the visual axis then being more nearly parallel with the muscle plane, and the rectus muscles show their effect when the eye is abducted, for the corresponding reason.

Hence in beginning paresis of the right superior oblique muscle there will be no deviation (single vision) upward, and on looking down the right eye will lag, especially in adduction (looking to the left). On the other hand, the torsional effect will be most marked when the eye looks down to the right. When the right eye (the paretic eye) fixates, the deviations, i. e., secondary deviations, are greater (but not the tilting).

The effect of head tilting toward the right or left shoulder is a strictly postural reflex from the semicircular canals. Tilting the head to the right makes the eyes tilt to the left and vice versa; i. e., the eyes try to correct by torsion in the opposite direction the tilting of the vertical meridian produced by head tilting. Hence the superior oblique muscle is called on, together with the other inward roller, the superior rectus muscle, to tilt the right eye to the left when the head is tilted toward the right. If the superior oblique muscle is paretic, the superior rectus muscle acts practically alone. Hence it not only produces some intorsion as required but rotates the eye upward, since it is unopposed by the superior oblique muscle, which under normal conditions aids the superior rectus muscle in the torsion but acts against it in elevation.

#### HISTORICAL REVIEW

Red-green spectacles are quite old. Forty years ago Dr. Charles Williams used them and a red-green tangent cross for measuring deviations, esophoria, exophoria, hyperphoria and cyclophoria. I had such an apparatus in my office in the 1890's. But red-green spectacles were used long before that for malingering and other tests.

Thirty years ago W. R. Hess proposed a tangent screen. black with red lines and with sizable red spots at the nine cardinal points. The

patient wore red-green spectacles and held a wand to the end of which was attached a green spot. He was instructed to place the green spot on the various red spots of the screen which was 0.5 meter distant.

Twelve years ago Sattler published a modification of this, using a longer working distance and larger screen.

The method of interpreting the findings advocated by Hess is to make a diagram of the deviations. The red spots are already connected by lines. The green spots are to be connected and thus form a quadrilateral figure. Hess has published a series of typical charts of the results of tests in cases of various types of paralyses. To make a diagnosis, a published chart is selected which corresponds to the chart that has been drawn. No understanding of the actions of the muscles is supposed to be required to make the diagnosis. The interpretation is not made from pathologic actions on the basis of physiologic actions as should be done by the ophthalmologist who knows the muscles. It is by use of diagrams. Dr. Cogan,<sup>4</sup> who saw the method in use in Europe last summer, was not favorably impressed.

Zeiss is at the present time putting on the market a double projector with reversible red-green filters before the eyes. There is an ingenious method of recording. I have had an opportunity to examine the instrument. It can be used for detecting, measuring and recording deviations and will be preferred by those who want complicated and expensive apparatus in their offices. The working distance is 1 meter. This, of course, does not eliminate the near reflex. The price is \$600. I have as yet seen nothing in print about this instrument except in the Zeiss catalogue.

#### SUMMARY

In the ordinary diplopia test a single light is seen as two, and the apparent position of the two lights measures the deviation.

In my test two lights are thrown on the screen, red for the right eye and green for the left eye. The lights are so placed that their images fall on the foveas of the respective eyes and so are superimposed in the mind of the patient. Two lights are seen as one. One light is thrown on the screen by the examiner at any point desired for fixation. The patient shows the position of his other eye by projecting the light seen by that eye so that to him it is superimposed on the first light. Its position on the tangent screen shows what the deviation is.

Cards are provided for easy recording with a red and green (or blue) pencil.

Fixation with the other eye can be had by exchanging projectors.

The projectors may be used for mapping fields, especially central scotomas.

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4. Cogan: Personal communication to the author.

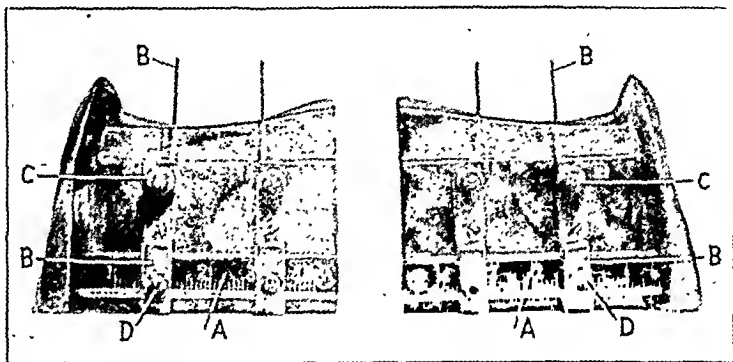
# Clinical Notes

## REGISTERING DEVIOMETER

An Instrument to Measure the Degree of Squint

M. E. SMUKLER, M.D., PHILADELPHIA

The deviometer, right and left (as shown in the accompanying illustration), is made of dental rubber with polished surfaces. The inner surface conforms to the shape of the face below the margin of the lower eyelid and the side of the nose. The outer surface is flat, having on it a millimeter scale bar (*A*) with two sliding dials (*B*). The upper thumbscrew (*C*) adjusts the dial forward or backward for prominent



Registering deviometer, right and left. *A* indicates the millimeter scale bar, *B*, the sliding dials; *C*, the upper thumbscrew, and *D*, the lower thumbscrew.

or for deep-set eyes. The dials are moved laterally and fixed by the lower thumbscrew (*D*).

Several methods have been employed to measure the angle of squint. Linear strabismometry, at one time the popular method, is almost obsolete. Later, this plan was followed by estimating the position of the corneal reflex. The newer methods depend on observing the movement of each eye as its visual axis is directed to a fixation point.

With this deviometer the angle of squint (in distant and in near vision) of children and adults may be measured quickly and accurately for clinical purposes. The angular measurement is not absolutely correct mathematically, as the dials are moved on a straight line instead of an arc. However, the speed and ease with which this instrument can be used outweigh the slight error in measurement ascertained by expensive, complicated and time-consuming instruments, which cannot always be applied to children or unintelligent adults.

### METHOD OF USE FOR CONVERGENT SQUINT

The patient is placed facing a window. The fixing eye is covered, and the patient's attention is directed to some distant object (a near object, if the measurement for near vision is desired). The deviometer is placed just below the

margin of the lower lid and firmly against the nose of the squinting eye. The outer dial is slid directly over the outer limbus and fixed with a thumb-screw. The fixing eye is then uncovered and when the squinting eye returns to its usual position the inner dial is placed over the external limbus and fixed by the thumbscrew. The rotation of the globe is the distance between the dials and is noted on the millimeter scale. One millimeter is equal to  $4\frac{1}{2}$  degrees of squint.

The same procedure is reversed if the measurement is made from the internal limbus. The operation is easier and the arc theoretically larger if the estimation is made from the external limbus. For divergent squint the inner dial is placed over the external limbus of the squinting eye, while the fixing eye is covered and the outer dial is placed over the external limbus when the fixing eye is uncovered.

1940 North Broad Street.

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### ACUTE ABSCESS OF THE LYMPH FOLLICLES OF THE CONJUNCTIVA

JAMES P. RIGG, M.D., AND RICHARD WALDAPFEL, M.D., GRAND  
JUNCTION, COLO.

Concerning pathologic involvement of the lymphoid tissue of the eye, there is still much unknown. One is more familiar with the normal anatomic picture.<sup>1</sup> The lymphoid tissue is found in the superficial adenoid layer of the conjunctiva and is formed only in the third to the fourth month of life. It is thin, and the main formation is in the fornix. It consists of a fine connective tissue reticulum in the meshes of which the lymphocytes are embedded.

These lymphocytic aggregations consist, as everywhere in adenoid tissue, for example, the pharyngeal mucous membrane, of two types: simple diffuse gatherings of lymphocytes without special structure and, less frequently, collections of lymphocytes in the shape of nodules, called lymphatic nodules or (secondary) lymph follicles. These lymph follicles, if typically formed, consist of a lighter inner zone with large cells which take a lighter stain and an external darker zone consisting almost exclusively of lymphocytes. The inner zone is called the germ center and is rarely found in the eye.

There has been considerable research and a great deal written in recent years with reference to the physiologic function of these lymph follicles; however, we do not care to present much of this material and will only mention it in passing. While the first investigators (Fleming

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Presented before the Colorado Ophthalmology Society, Pueblo, Colo., May 27, 1939.

1. Duke-Elder, W. S.: *Textbook of Ophthalmology*, St. Louis, C. V. Mosby Company, 1938, vol. 11. Wolff, E.: *Anatomy of the Eye and Orbit*, Philadelphia, P. Blakiston's Son & Co., 1933.

and others) regarded these follicles as centers of lymphocytic production and the external darker zone as newly formed lymphocytes, later investigators were more inclined to the opinion that these centers have besides this function at least one other, namely, to assist in the fight against invading enemies, bacteria and toxic products.

#### REPORT OF A CASE

The observations described in the following case report furnish a contribution to the knowledge of pathologic involvement of the lymphoid tissue of the eye.

Mrs. J. J. F., aged 35, presented herself for examination. She had never noticed any previous trouble with her eyes, but for three or four days before examination the left eye was inflamed and the lids stuck together in the morning. She did not feel well generally, and the eye was moderately painful and felt scratched.

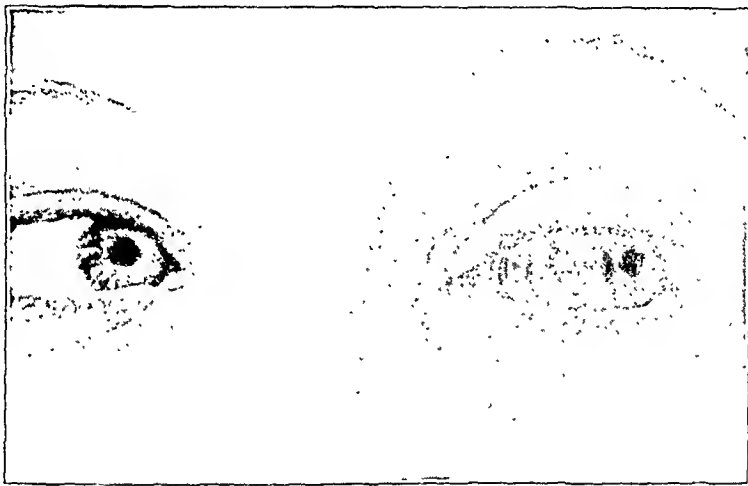


Fig. 1.—Clinical appearance of the patient. (Black and white photograph, green filter, Wratten B 58.)

The temperature was 99.4 F. The right eye was normal, including the adnexa. The nasal portion of the conjunctiva of the left eye was much inflamed, and a mucopurulent discharge was present. The medial portion was edematous and swollen. About in the middle of this inflamed area, midway between the limbus and the caruncle, there was a small elevation with a yellowish center and a deeply inflamed margin. The elevation did not give the appearance of an ulceration but of pus shining through the cup at the top of the elevation; it was a little atypical for any of the ordinary acute conjunctivitides. It was freely movable, and the whole infection was in conjunction with the conjunctiva. A photograph of this unusual condition was made, and as much as can be represented in black and white is shown (fig. 1).

One immediately sees the difference between the right and the left eye, the normal white sclera shining through the conjunctiva of the right eye and the deep vascularized and partially swollen area of the left eye. About in the middle of the inflamed area are depicted the elevation with the yellowish center and the red inflammatory halo surrounding it, with dilated vessels visible and filling the whole area between the caruncle and the limbus.



## COMMENT

Fuchs<sup>2</sup> described a condition similar to this as a variation of acute conjunctivitis and called it pustulous catarrh on account of the pustular formation. We thought of this possibility and at the same time of an inflamed cyst or of a foreign body, or even perhaps of a pinguecula, although the history did not indicate any of these diagnoses; the patient had not noticed anything that would indicate a cyst or a pinguecula, and the lack of a sudden incipency and of a sensation of something in the eye, as well as the increased temperature and general malaise, spoke against a foreign body.

The entire picture and the circumscribed infection appeared much more like a suppurating infection of a lymph follicle, such as one some-

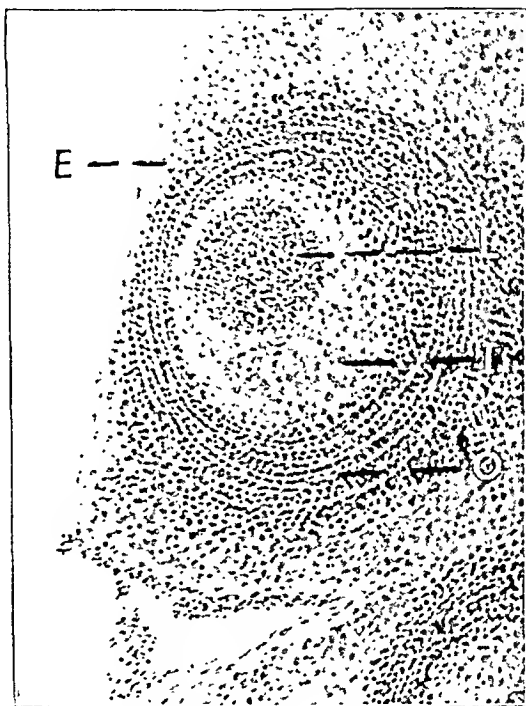


Fig. 2.—Abscess of the lymph follicle in cases of acute tonsillitis. *E* indicates the epithelium; *I*, the inner light zone of the lymph follicle (germ center); *O*, the outer dark zone, and *L*, the focus of leukocytes and streptococci within the inner zone.

times sees in acute infections of the lymphoid tissue of the mucous membrane of the pharynx, in acute pharyngitis or in tonsillitis.

Grossmann and Waldapfel<sup>3</sup> in 1925 described the microscopic picture of such inflammations of the lymph follicles in acute tonsillitis (fig. 2). At the climax of tonsillitis there are to be found in the interior of these

2. Fuchs, E.: *Diseases of the Eye*, ed. 10, translated by E. V. L. Brown, Philadelphia, J. B. Lippincott Company, 1933.

3. Grossmann, B., and Waldapfel, R.: Lacunar Tonsillitis, *Acta oto-laryng.* 10:1, 1925.

follicles in the lighter zones, centrally or eccentrically situated, sharply limited foci of leukocytes and streptococci, which indicate genuine small abscesses; these are more remarkable when one remembers that the normal lymph follicle and its center do not contain any leukocytes. This pathologic microscopic picture represents an important link in the chain of evidence which speaks for the protective function of the lymph follicles and of the lymphoid tissue. This microscopic picture corresponds to the macroscopic clinical picture of the pus shining in the cup at the top of the elevation, such as is found on pharyngeal membrane and on the tonsils, singly or multiply, in febrile infections of the throat.

The similarity of the conjunctival infection to these pharyngeal infections was striking, and because a normal anatomic basis exists for the development of this pathologic process, we should regard the condition by analogy as suppuration of a lymph follicle of the conjunctiva.

(In the case reported, excision of the abscess and the application of a 2 per cent solution of silver nitrate resulted in healing of the area and a practically normal eye within three days.)

It is not impossible that the so-called pustulous catarrh of the conjunctiva represents regularly such follicular abscesses in the conjunctiva.

This suggestion, made on the basis of the clinical picture, remains to be verified microscopically, as in infections of the pharynx. The report of further observations of this kind is desirable.

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## HUMAN BITE OF THE EYELIDS

### Report of Case

HAROLD R. SNIDERMAN, M.D., CINCINNATI

Wounds produced by human bites usually produce severe infections, which tend to spread diffusely, discharge foul pus, yield slowly to treatment and cause severe complications and deformities.<sup>1</sup>

Human bites may be penetrating or of an avulsive type, complete or incomplete.

The common organisms found in wounds produced by human bite are *Staphylococcus aureus*, *Staphylococcus albus*, streptococci of various types, the fusiform bacillus, the spirillum of Vincent's angina and numerous spirochetes.

Eighty per cent of human bites, according to reports, are bites of the hand, produced, as a rule, by the fist striking the teeth of another. No case of human bite of the eyelids was found reported in the recent literature, and it is easily understandable that this should be a rare occurrence.

The treatment of human bites has been the subject of numerous surgical reports. Ordinary surgical methods were unsatisfactory.

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From the Department of Ophthalmology, the Cincinnati General Hospital.

1. Dunn, E. P.: Human Bites, *Am. J. Surg.* 36:44 (April) 1937.

Lowry<sup>2</sup> stated that for fresh bites undoubtedly the best treatment is actual cauterization or radical débridement. He uses fuming nitric acid followed by cold water. All wounds are left unsutured. The foregoing procedures are formidable and in the eyelids would involve the loss of important structures. Leaving a wound of the eyelid as extensive as the one to be described unsutured would have resulted in a marked deformity. Plastic procedures would have been necessary later.

#### REPORT OF A CASE

R. L., aged 48, a Negro, was admitted to the hospital one hour after receiving an avulsive tear of the right eyelids, inflicted by the bite of a Negress.

The wound in the upper lid extended from the inner canthus at the margin of the lid laterally three fourths of the length of the lid. At the midpoint of the lid it was 10 mm. above the margin of the lid. The wound was through the skin, the orbicularis oculi muscle, the superior levator palpebrae muscle and the conjunctiva. The tarsus was lacerated at two points along the margin of the lid and extended vertically for about 5 mm.

The lower lid was similarly avulsed from the inner canthus laterally, from the skin through to the conjunctiva.

The lacerations passed through the lacrimal canaliculi. The eyeball was not involved.

The patient was taken to the operating room and the wound repaired, local anesthesia being used.

The skin was surgically prepared with soft soap and tincture of merthiolate. The wound was thoroughly irrigated with a solution of mercury bichloride (1:5,000).

The ends of the levator palpebrae superioris muscle were sutured with double-armed sutures of chronic 000 ten day catgut. The tears in the conjunctiva and the tarsus were approximated with interrupted black silk sutures. The orbicularis oculi muscle was not sutured. The skin was closed with interrupted black silk sutures. A small rubber drain was left in the wound.

The skin, conjunctiva and tarsus of the lower lid were sutured with interrupted silk sutures. No drain was used.

The use of ice compresses over the right eye was started immediately after operation. Twenty grains (1.3 Gm.) of sulfanilamide was given by mouth five times daily.

On the third day after operation the wound was clean. The drain was removed. The concentration of sulfanilamide in the blood was 9.1 mg. per hundred cubic centimeters of blood.

On the fifth day the dose of sulfanilamide was decreased to 60 grains (3.9 Gm.) daily. The wound was healing by primary intention at all points except where the drain was removed, at which point there was a little unhealthy looking granulation tissue.

On the seventh day after operation the sulfanilamide was decreased to 40 grains (2.6 Gm.) daily. All skin sutures were removed. The wound was clean. The patient's only complaint was a little epiphora. He was able to elevate his lid, and there was little swelling present.

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2. Lowry, T. M.: Surgical Treatment of Human Bites, *Ann. Surg.* **104**:1103 (Dec.) 1936.

At the end of two weeks the wound was healed. The patient was able to open and close his lids normally. He was discharged from the hospital.

One month later the patient complained only of occasional epiphora. The lids appeared normal.

#### COMMENT

This is an unusual injury of an eyelid. No attempt was made to carry out débridement or cauterization of the lacerated tissue as is advocated for the treatment of human bites. I was fully aware of the possibility of a destructive infection with ultimate deformity. Leaving the wound open without suturing was not considered. Thorough irrigation of the wound was done within two hours after the injury. Post-operatively, the patient was given sulfanilamide by mouth, and on the third day a blood determination showed adequate concentration.

No attempt is made in this report to overemphasize the part played by sulfanilamide in the patient's uneventful recovery. The regularly advocated methods of treatment for human bites were not considered suitable in this case because of the extensiveness of the wound and the added destruction which this treatment would have necessitated.

# News and Notes

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## SOCIETY NEWS

**George Brewster and Jennie Mathews Honorarium.**—An honorarium of \$1,000, the George Brewster and Jennie Mathews honorarium, to promote research work in ophthalmology is offered through the International Association for the Prevention of Blindness, the jury to consist of the members of the executive committee together with the president and the officers of the association.

The award will be made in connection with the Sixteenth International Ophthalmological Congress. Papers may be presented by any responsible research worker. The subject is to be "Simple Noninflammatory Glaucoma" and may include anything definitely relative to the question. The matter must be new and of such value, in the judgment of the jury, as to merit this recognition. Papers may be written in English, French, German or Italian; in order to facilitate the task of the jury, papers written in the last two languages should be accompanied by a translation in English or French. They should be in the hands of the secretary of the International Association for the Prevention of Blindness, 66 Boulevard Saint-Michel, Paris, France, through whom they will reach the members of the judicial committee not later than six months before the date of the congress.

The decision of the jury will be final.

## GENERAL NEWS

**Special Lecture Course.**—The department of ophthalmology of the Manhattan Eye and Ear Infirmary has announced a schedule of evening lectures to be given through October and November on Monday and Thursday evenings at 7 o'clock to hospital residents and graduate students.

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## Notices

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### CUMULATED INDEX OF THE ARCHIVES OF OPHTHALMOLOGY

Requests have been received for a ten year index of the ARCHIVES OF OPHTHALMOLOGY. Before serious consideration is given to the production of a cumulated index, it is desirable to know whether the demand for it would be sufficient to warrant its sale at not to exceed \$5 per copy. It will be appreciated if those who are interested in such an index will send a card or note to this effect addressed to the Managing Editor at the publication office, 535 North Dearborn Street, Chicago.

# Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

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## Congenital Anomalies

FAMILIAL OCCURRENCE OF CONGENITAL MICROPHTHALMOS. F. K. LEYDHECKER, Arch. f. Ophth. 139:790 (Dec.) 1938.

The pedigree of a German family is reported in which congenital microphthalmos occurred in 8 persons belonging to 5 consecutive generations. In those of the affected persons who reached the age of 40 a noninflammatory form of glaucoma developed which did not respond to treatment. The pedigree shows that the inheritance of congenital microphthalmos follows the dominant mode.

P. C. KRONFELD.

## Cornea and Sclera

STUDIES ON THE BACTERIOLOGY OF HYPOPYON ULCER. A. J. RHODES, Brit. J. Ophth. 23:25 (Jan.) 1939.

The work was initiated owing to the fact that over half of the hypopyon ulcer seen at the ophthalmic department of the Royal Infirmary of Edinburgh occur in mine workers (coal or shale), which appears to be an unduly high percentage.

Rhodes gives the following summary:

"1. The conjunctival flora of 658 healthy coal mine-workers has been examined, representing 4 different pits.

"2. In two pits the oncost-worker evidently harboured a more profuse flora than the other workers.

"3. Apart from this, below-ground workers did not harbour a flora essentially different from that of surface workers.

"4. The following potentially pathogenic organisms may be found in all groups of workers in significant quantity; streptococcus viridans, pneumococcus, diplobacillus of Morax, haemophilic bacilli and B. coli.

"5. Streptococcus viridans occurred in 11.25 per cent of persons.

"6. Fifty-four strains of pneumococcus were encountered (representing 8.1 per cent of the workers), but only one of these fell into a main type (type 3). The bulk of the remainder proved avirulent to the mouse, but showed typical reactions otherwise.

"7. The distribution of diplobacillus of Morax was somewhat irregular, occurring in 2.3 per cent of all workers in pits L V and W, and in 6.76 per cent at pit A.

"8. Haemophilic bacilli were isolated from 1.5 per cent of persons, and B. coli from 0.75 per cent.

"9. It is considered that the conjunctival flora of coal mine-workers is potentially dangerous and that the source of infection in hypopyon

ulcer is from organisms already present in the conjunctival sac. Those most liable to contract the disease are those most exposed to corneal trauma—the miners and brushers.”

This study serves to emphasize the importance of shielding the eyes of those exposed to risk of corneal injury and if such an injury does occur, the care with which it should be treated. W. ZENTMAYER.

STUDIES ON THE BACTERIOLOGY OF HYPOPYON ULCER. A. J. RHODES, *Brit. J. Ophth.* 23: 38 (Jan.) 1939.

The work reported in the article is a direct continuation of the author's study on conjunctival flora of coal mine-workers (*Brit. J. Ophth.* 23: 25 [Jan.] 1939).

Rhodes gives the following summary:

“1. The conjunctival flora of 189 shale workers has been examined.

“2. Shale workers harbour significant quantities of potential pathogens such as streptococcus viridans, pneumococcus (group 4), diplobacillus of Morax, haemophilic bacilli and B. coli.

“3. The evidence adduced is additional support for the belief that the source of infection in hypopyon ulcer is already present in the conjunctival sac, and that the mine worker's conjunctival flora definitely predisposes him to infection.

W. ZENTMAYER.

BILATERAL MESIAL SUPERFICIAL “DEFICIENCY” OF THE SCLERA (SCLERAL PLAQUES). B. GRAVES, *Brit. J. Ophth.* 23: 191 (March) 1939.

Graves first described this condition under the first of the two titles given here in 1937 and at that time concluded that it was a developmental defect.

In the present article he describes a second case, giving in minute detail the biomicroscopic changes found in the cornea, with an explanation of the phenomena noted. The changes suggest the correctness of the proposal of Mann and also of Culler that the scleral defects may represent a hyaline change. Graves believes that the scleral defect involves an actual thinning.

In a recent case there was a strong suspicion of lateral as well as mesial lesions; if so, it is the only instance in which the author has seen lateral plaques. The article is profusely illustrated.

W. ZENTMAYER.

### Experimental Pathology

OCULAR LESIONS IN ARTERIAL HYPERTENSION INDUCED BY RENAL ISCHEMIA. I. C. FASCILOLO and F. K. CRAMER, *Compt. rend. Soc. de biol.* 130: 289, 1939.

Of 28 dogs subject to renal ischemia, ocular lesions were observed in 8 one to two weeks after operation. The ocular alterations occurred only when the arterial pressure surpassed 200 mm. of mercury. Hemorrhages were noted subconjunctivally and in the anterior chamber and

in the vitreous. Microscopic examination of the choroid revealed small interstitial hemorrhages. In 5 cases there was partial or total retinal detachment; and in 3 of the cases of less acute involvement small whitish yellow exudates became visible ophthalmoscopically.

J. E. LEBENSOHN.

INFLUENCE OF ASPIRATION OF THE ANTERIOR CHAMBER ON THE COURSE OF TUBERCULOUS IRITIS. P. JABOTINSKAYA, *Vestnik oftal.* 13: 520, 1939.

Experimental aspiration of the anterior chamber was undertaken in the Ukrainian Institute of Ophthalmology in order to find out whether this simple procedure could be substituted for the more complicated introduction of blood into the anterior chamber after the method of Schick.

A series of rabbits were infected by an emulsion of the bovine type of tuberculosis bacilli by injecting it into the vein of the rabbit's ear. In 5 of these typical tubercles developed in the iris; in 3 of the rabbits repeated aspirations of the anterior chamber were done, while the other 2 served as control animals. The histories are given in detail. The aspiration caused only a transitory improvement of the process, as in a few weeks the course of the disease was invariably worse than before the aspirations were started. The fellow eye at times also reacted unfavorably. The time of observation was from six to eight months.

O. SITCHEVSKA.

### General Diseases

FUNDUS CHANGES IN PERSONS WITH DIABETES. K. VOM HOFE, *Arch. f. Ophth.* 139: 801 (Dec.) 1938.

Pinpoint hemorrhages in the superficial or deeper layers of the retina are the most characteristic fundus change of diabetic patients. The retinitic lesions which one also sees in such persons may be situated in any of the retinal layers. There is no shape or arrangement of these lesions which could be called characteristic of diabetes. Diabetic periphlebitis is rare in Germany. In the large majority of diabetic patients with retinal lesion there is evidence of a cardiovascular hypertensive disease. Retinitis, however, is more common in diabetic patients with hypertension than in nondiabetic patients with hypertension. Factors other than the hypertension must therefore play a part in causing diabetic retinitis. The large majority of the author's patients showed visible alterations of the retinal vessels, which, in addition to occurrence of pinpoint hemorrhages, proved that the vessel wall had been damaged. Edema of the disk or retina is extremely rare in diabetes. Insulin does not seem to be injurious to the retina of the diabetic patient. The cholesterol and the nonprotein nitrogen contents of the serum are occasionally increased in patients with diabetic retinitis.

P. C. KRONFELD.



## Glaucoma

THE BIOLOGICAL ANALYSIS OF THE AQUEOUS HUMOR IN GLAUCOMATOUS PATIENTS. N. PLETNEVA, N. RAEVA and E. VORONINA, *Vestnik oftal.* 13: 462, 1938.

The authors give a detailed review of the literature on the connection between the autonomous nervous system and the intraocular tension, particularly that of the article by Lowewi and Velhagen in which they stated that the autonomous nerves act on the peripheral organ through chemical substances. One of these substances is acetylcholine, liberated by the vagus nerve, and the other is sympathin, liberated by the sympathetic nerve.

Rayeva and Voronina had previously found that the electric stimulation of the sympathetic and the oculomotor nerves causes also a change in the aqueous. The purpose of this work was to establish the character of the aqueous in glaucoma by biologic analysis.

The aqueous was obtained during the operations for glaucoma and cataract extractions, as an attempt at obtaining the aqueous by aspiration in cases of chronic glaucoma aggravated the process. The aqueous, diluted with Ringer's solution, was examined and put through the isolated heart of a frog. The action of the heart was registered by a kymograph. The aqueous of cataractous eyes was used as a control. One hundred eyes were examined; of these, 55 were glaucomatous, 41 were cataractous and 4 were affected with traumatic iridocyclitis. The analysis showed that in 52 per cent there was a sympathicotropic substance and in 34 per cent a vagotropic substance, i. e., a substance causing the acetylcholine action or retardation of the heart action.

Five kymographic photographs illustrate an acceleration of the heart (sympathicotropic agent) in some and a retardation of its action in others, which condition might be caused either by acetylcholine or by histamine. Since acetylcholine becomes inactive in the presence of blood (while histamine is not affected by it) in the anterior chamber, the authors examined the action on the isolated frog's heart of defibrinated blood of 2 glaucomatous and of 3 nonglaucomatous patients in whose aqueous acetylcholine was present. The heart rhythm was found unchanged in all eyes. The authors therefore believe that the aqueous of glaucomatous patients produces the vagal effect because of the presence of histamine in some and of the acetylcholine in others. The presence of both, vagotropic and sympathicotropic substances, in the aqueous of glaucomatous patients confirms the opinion that the two parts of the vegetative nervous system act as synergists and that their balance is disturbed in glaucoma.

The practical value of this work is discussed with reference to the use of pilocarpine and physostigmine salicylate. The latter increases the action of acetylcholine and prevents it from degeneration, while pilocarpine stimulates the parasympathetic system and causes an increase of acetylcholine. These problems are being worked on by the authors.

O. SITCHEVSKA.

## Injuries

BIRTH INJURIES OF THE CORNEA AND ALLIED CONDITIONS. R. I. LLOYD, *Am. J. Ophth.* 21: 359 (Nov.) 1938.

Lloyd discusses the genesis and different types of birth injuries of the cornea. He reports 6 cases, in all of which the left eye was the one affected. This is to be expected because of the preponderance of left occiput anterior presentations which bring the left eye to the rear. Pigmentation of the posterior corneal and anterior lenticular surfaces are explained by late separation of the cornea from the tunica vasculosa lentis. This may in turn be the result of delayed formation of the anterior chamber and should direct one's attention to buphthalmos.

W. S. REESE.

## Lens

INTRACAPSULAR EXTRACTION OF CATARACT. R. ARGANARAZ, *Arch. de oftal. de Buenos Aires* 13: 589 (Nov.) 1938.

The author stresses the fact that the extraction of cataract in toto does not fulfil the desirable conditions of more certainty in the operative procedure, the least danger of complications and the assurance of a maximum of vision.

The different methods are examined with the difficulties arising from different circumstances, and recommendations are given as to the best means of avoiding them.

C. E. FINLAY.

CAPSULAR EXFOLIATION OF THE LENS CRYSTALLINE (VOGT) ASSOCIATED WITH THROMBOSIS OF THE TEMPORAL RETINAL VEIN AND STAHLI'S LINE. D. ARGUELLO and B. TOSTI, *Arch. de oftal. de Buenos Aires* 13: 681 (Dec.) 1938.

A case is here clinically described in which the slit lamp findings revealed capsular exfoliation of the lens as described by Vogt; there was some atrophy of the iris, and on the posterior surface of the cornea a horizontal line of pigment (Stahli's line) was discernible. The fundus showed occlusion of a temporal vein.

C. E. FINLAY.

THE ROLE PLAYED BY THE IRIS IN THE DEVELOPMENT OF INFRA-RED CATARACT. A. BAKKER, *Arch. f. Ophth.* 139: 677 (Dec.) 1938.

The controversy between Vogt and Goldmann with regard to the mechanism of infra-red cataract is reviewed. Vogt asserts that the cataract which develops in rabbits after exposure of their eyes to large doses of heat rays of from 750 to 1,350 millimicrons wavelength (so-called penetrating infra-red rays) is caused by absorption of these rays by the lens and therefore represents a true radiation cataract. Goldmann, on the other hand, interprets his experimental evidence to mean that the rays under consideration are chiefly absorbed by the iris and that the heat conducted from the iris to the lens causes the cataract. Bakker, the author of the paper under review, is known for his studies on the surviving lens, in which he made use of de Haan's method of

tissue culture. The principle of this method is to keep the explanted organ or tissue perfused with peritoneal transudate, which slowly circulates through the culture vessels. Explanted lenses, treated after this method, have been shown to maintain their normal morphologic and metabolic characteristics for several weeks. Bakker has repeated Vogt's and Goldmann's experiments on such surviving lenses and reports that the lens does not absorb an appreciable amount of penetrating infra-red rays. On the contrary, after the rays had passed the whole thickness of one explanted lens without producing a cataract, they produced extensive opacities in a second explanted lens which was covered with iris. All experiments show that the iris plays an important part in the development of the cataract. Even if irradiation is strictly confined to the iris, opacities of the lens develop. Bakker concludes that Vogt's so-called specific infra-red cataract is just a heat cataract.

P. C. KRONFELD.

### Methods of Examination

NIGHT BLINDNESS. K. TANSLEY, *Brit. J. Ophth.* 23: 161 (March) 1939.

The author reviews the literature pertaining to night blindness and its relation to vitamin A deficiency and criticizes the work done in taking the dark adaptation curves to detect slight degrees of malnutrition due to deficiency of vitamin A.

The conclusions are:

"There is no doubt at all that variations from the normal adaptation curve can be used to diagnose vitamin A deficiency, provided the test is made by experienced observers with suitable apparatus and over a sufficiently long period of dark adaptation. It is, however, extremely doubtful whether this particular method can ever be of any great value under the conditions which obtain when wide nutritional surveys of populations are attempted. In order to obtain a reliable dark adaptation curve the services of a skilled experimenter with elaborate apparatus are an absolute necessity and at least an hour is required for each individual test. These conditions are obviously not attainable when several hundred subjects have to be tested over a relatively short period."

W. ZENTMAYER.

SODIUM LIGHT AS AN AID IN DETECTION OF MALINGERING IN OPHTHALMOLOGY. A. BAKKER, *Arch. f. Ophth.* 139: 267 (Sept.) 1938.

Bakker describes a device with which a Snellen chart can be illuminated with red, green or yellow rays from a sodium lamp. The patient is seated opposite the chart, wearing his correcting lenses if ametropia is present. The examiner pretends to concern himself only with the patient's good eye but warns him against closing one eye. The examiner then puts a green glass over the patient's good eye and turns the green light on the Snellen chart. The patient reads with his good eye. If he should close his "bad" eye, he only finds out that he is reading with his good eye. Then a red glass is put over the good eye and the red illumination turned on. Again the patient reads with his good eye.

Another red glass is put in front of the good eye and the sodium lamp turned on. The rays emitted by this lamp are absorbed by the red glass in front of the patient's good eye. Thus he unknowingly reads with his "bad" eye.

P. C. KRONFELD.

### Neurology

RELATIONS BETWEEN TABETIC ATROPHY OF THE OPTIC NERVE AND ALTERATIONS OF THE BLOOD PRESSURE AND INTRAOCULAR PRESSURE. T. E. DIMITRIOU, *Arch. f. Ophth.* 139:704 (Dec.) 1938.

The author, a pupil of Carl Behr, confutes Sobanski's theory that tabetic atrophy of the optic nerve is caused chiefly by a disproportion between intraocular pressure and the pressure in the retinal arteries. According to this view, tabetic atrophy of the optic nerve should start in the retina. The pathologic studies made during the last twenty years have proved that the tabetic degeneration starts in the retrobulbar portion of the nerve. According to Sobanski, tabetic atrophy combined with glaucoma should take a malignant course. During the last ten years this combination was seen in only 3 cases in Behr's clinic. In these 3 cases the course of the atrophy was "strikingly benign." There was no dependence of the visual function on the ratio blood pressure: intraocular pressure. A review of the recent literature shows that low blood pressure is not more common in tabetic than in nontabetic subjects of the same age. According to Sobanski, retinal circulation is sufficient if the diastolic pressure in the retinal arteries is 20 mm. of mercury higher than the intraocular pressure. Dimitriou asserts that this postulate is arbitrary and cites cases of aortic insufficiency in which, without any ill effect on the retina and optic nerve, for years the diastolic retinal blood pressure could not have been higher than the intraocular pressure. According to Dimitriou, not the diastolic or lowest pressure but the arithmetic mean between systolic and diastolic pressure are significant for the nutrition of the tissues.

P. C. KRONFELD.

TUBEROUS SCLEROSIS OF THE BRAIN, WITH VAN DER HOEVE'S RETINAL PHACOMAS. M. ANKER and A. KVEIM, *Acta ophth.* 16:454, 1938.

Tuberous sclerosis of the brain manifests itself by the formation of multiple tumor-like foci in the central nervous system, retina, skin, kidneys, heart, thyroid and mammary glands and sometimes in the skeleton. The disease is hereditary and appears in childhood, the patients showing late development and retarded mentality. Death before the age of 30 is usual.

Sclerotic foci are found in the cortex, in the central ganglions and in the walls of the lateral ventricles. These consist of a rich glial proliferation with large peculiar cells which are in part atypical ganglion cells and in part atypical glial cells. The ventricular tumors are often calcified. The cutaneous changes are called "adenoma sebaceum" and are found especially on the sides of the nose, on the cheeks and on the chin, but they may occur anywhere on the surface of the body. The fundi show typical tumor formations and occasionally atrophy of the optic

nerve. The disease is closely related to Recklinghausen's and to Lindau's disease.

In all 3 of the cases reported by the author there were observed thin connective tissue veiling the papilla, strands along the retinal vessels, raspberry-like white tumors and small, flat, slightly protruding white foci along with small areas of choroidal atrophy. These observations correspond to those of van der Hoeve, published in 1921. The histologic structure of the retinal tumors has been described by van der Hoeve. Such tumors arise from the nerve fiber layer and to a less extent from the ganglion cell and inner plexiform layers. They consist of nerve fibers and glial tissue and also contain large undifferentiated cells, which are held to be forerunners of glial and ganglion cells. Usually these tumors remain unchanged for years and do not damage the eye except to reduce visual acuity if they are situated on the papilla.

O. P. PERKINS.

### Ocular Muscles

FUNCTION AND DEVIATION OF THE SQUINTING EYE. J. ZIERING, Arch. f. Ophth. 139:759 (Dec.) 1938.

The author studied the function of the squinting eye in 112 persons with concomitant strabismus under conditions of monocular as well as of binocular vision. Characteristic of unilateral strabismus was a considerable difference between the unaided vision of the two eyes. In the cases of bilateral or alternating strabismus the vision of the two eyes was approximately the same. Severe amblyopia (vision ranging from 0.5/60 to 6/60) occurred only in the cases of unilateral strabismus and was always associated with extrafoveal or defective foveal fixation and with a central scotoma demonstrable by monocular perimetry (the "amblyopic triad"). The presence of the abnormal fixation made the demonstration and the tracing out of this scotoma difficult. The scotoma always concerned the retinal area which the patient was using for fixation. For white targets of 3/1,200 size the scotoma was absolute (and paracentral) in the cases of extrafoveal fixation and relative (and central) in the cases of central fixation.

Interesting were the results obtained by binocular perimetry. A red target (5/1,200 to 25/1,200) mounted on a white strip of cardboard was used. One eye was excluded with a suitable glass filter, that is, prevented from seeing the target. With this method the author found in almost all of his cases a "scotoma" (the term "area of suppression" would probably be preferred in the United States and England) which occupied the retinal area corresponding to the fovea of the fixing eye. In addition, a large portion of the patients also showed a scotoma in the field of the fixing eye which corresponded to the macula of the squinting eye. Thus, there was mutual exclusion or suppression of the foveal images with the result of strictly monocular, alternating central vision. The occurrence of an exclusion scotoma in the fixing eye when the image of the target fell on the fovea of the squinting eye was interpreted as temporary taking over of the fixation by the squinting eye which had been induced to fix by the white cardboard part of the target. Such exclusion scotomas occurred in each eye of all persons with alternating squint and in some persons with, in the motor sense of the word,

unilateral squint. In cases of severe amblyopia there always was only one exclusion scotoma (in the amblyopic eye, of course). Sharply defined exclusion scotomas occurred chiefly in cases of convergent squint, whereas in cases of divergent squint the whole nasal half of the visual field of the squinting eye was excluded, the change from seeing to exclusion being a gradual one. Binocular perimetry not only revealed the way in which the two eyes cooperated in a patient with strabismus but gave clues with regard to the prognosis. If the foveal impressions of the squinting eye were completely excluded before operation, there was no danger of postoperative diplopia and practically no chance of attaining normal binocular fusion after surgical correction of the strabismus. In cases of alternating squint one could hope to obtain normal fusion after the operation if before the operation objects situated so as to form images on both foveas were fused. If the capacity of fusion under these conditions was weak, postoperative diplopia had to be expected. If in the presence of abnormal correspondence binocular fusion occurred before the operation, one had to be prepared for annoying and persistent postoperative diplopia.

The author sees in anisometropia the main cause of amblyopia. Before the establishment of ocular movements guided by fusion the child uses both eyes alternately but prefers one eye if the refractive state of the other is such as to make its use more difficult. Thus amblyopia develops through disuse during the first six months of life. The development of normal fusion, however, forces the amblyopic eye to cooperate with the other eye, whereby the amblyopia may be made to disappear. If, however, instead of normal fusion strabismus sets in, the amblyopic eye is given no chance to develop and remains in the state in which it was at the time of the onset of the strabismus. Squint in the amblyopic eye, therefore, develops not through loss of an already acquired function but through lack of a chance to acquire vision through proper training.

Only 25 per cent of the persons in whom the motor anomaly was corrected acquired second or third degree of fusion. In the remaining 75 per cent only a motor, that is, cosmetic, cure was achieved, the anomaly of binocular cooperation remaining unchanged. Improvement of the vision of an amblyopic eye on complete occlusion of its mate was slow.

P. C. KRONFELD.

### Pharmacology

ACTION OF PILOCARPINE (MIOTIC) ON MYDRIATICS. U. TESTA, *Rassegna ital. d'ottal.* 5: 680 (Nov.-Dec.) 1936.

The author conducted several experiments to establish the difference between a 2 per cent and a 6 per cent solution of pilocarpine in eyes with mydriasis produced by a 1 per cent solution of atropine sulfate and a 5 per cent solution of eucatropine.

He was able to show that neither of the two solutions of pilocarpine had any action on the mydriasis produced by atropine, while on the mydriasis produced by euphthalmine the solution had a quick, complete and lasting effect.

A. PERZIA.

### The Pupil

PECULIAR MOVEMENTS OF THE PUPIL. A. BAKKER, Arch. f. Ophth. 139: 273 (Sept.) 1938.

The pupillary movements referred to in this paper are: (1) the contraction which occurs immediately after tapping the anterior chamber and which cannot be prevented by previous atropinization, (2) the atropine-resistant contraction which has been reported in severe concussions of the brain and (3) the contraction of the explanted surviving rabbit iris which occurs on its immersion in the peritoneal exudate that Bakker uses for a tissue culture medium. The third form of contraction persists for a few days and is probably caused by the production of acetylcholine resulting from the traumatic stimulation of the oculomotor nerve during removal of the iris from the living eye. On the explanted iris it can also be shown that there are concentrations of acetylcholine which can overcome the effect of previously administered atropine. Contractions of the pupil which are resistant to atropine may, therefore, be due to strong stimulation of the oculomotor nerve resulting in the local production of large amounts of acetylcholine. Tapping of the anterior chamber constitutes, in the opinion of the author, such a strong stimulus for the third nerve.

P. C. KRONFELD.

### Physiologic Optics

NEW INVESTIGATIONS IN THE FIELD OF PHYSIOLOGIC OPTICS AND PSYCHOLOGY OF VISION. W. SCHEIDT, Arch. f. Ophth. 139: 85 (Aug.) 1938.

Scheidt is the author of several books ("Biologische Psychologie," 1934; "Grundlagen einer neurologischen Psychologie," 1937) in which the principles of neurophysiology and of neuropsychology are reviewed in the light of the synallax theory. According to this theory, the nervous system does not simply conduct the change produced in a stimulus-receiving organ by an effect of the outside world but connects with one another several of these receiving organs and adjusts and balances the differences in activity existing between affected and unaffected receiving elements. The processes which take place in these receiving stations are called incidences, whereas the term stimulus is reserved for the balancing process. This synallax theory is now applied to some fundamental visual processes.

P. C. KRONFELD.

### Physiology

THE FLUID EQUILIBRIUM OF THE BODY AND ITS RELATION TO THE EYE. J. D. ROBERTSON, Brit. J. Ophth. 23: 106 (Feb.) 1939.

The author describes the laboratory research on the fluid equilibrium of the body and its relation to the eye and makes the following conclusions:

"1. The formation of the aqueous humour is not governed by the same simple laws that govern the lymph, pleural and peritoneal fluids and other dialysates. Dialysis is therefore not a satisfactory explanation of the production of the aqueous humour.

"2. When the osmotic equilibrium in the body is disturbed in various ways the fluid formed in the stomach and the eye are disturbed rather similarly. This suggests that a secretory process in the eye may play some part in controlling the intra-ocular pressure.

"3. Ample evidence is available that the aqueous humour circulates from the posterior to the anterior chamber.

"4. Evidence seems to point to the site of formation of the aqueous humour being in the ciliary process.

"5. The aqueous humour leaves the eye at the angle of the anterior chamber into Schlemm's canal by some process which is not osmosis, and no fluid can leave the eye normally by the posterior chamber."

W. ZENTMAYER.

### Refraction and Accommodation

THE SIGNIFICANCE OF ERRORS OF REFRACTION IN CHRONIC BLEPHARITIS OF CHILDREN. E. J. SOMERSET, *Brit. J. Ophth.* 23:205 (March) 1939.

The purpose of this paper is to inquire into the significance of refractive errors as an etiologic factor in children suffering from chronic blepharitis or blepharoconjunctivitis. All the children forming the basis of this study were referred from hospitals and clinics in London and elsewhere after undergoing treatment generally for a long period. They are patients who had not responded to treatment in the outpatient department. In many instances correct glasses had been prescribed at the hospital or clinic without materially affecting the course of the disease. An analysis is given of the findings of refraction with atropine cycloplegia of the eyes of 300 children between the ages of 2 and 13 years.

The following summary is given by the author:

"(1) There is no significant difference in the spherical refractive error in children suffering from blepharitis in comparison with the normal child.

"(2) The incidence of astigmatism is similar in blepharitis cases and normal children.

"(3) Uniocular cases do not show blepharitis more frequently in the eye with the greater ametropia.

"(4) Causes other than errors of refraction must be sought for in blepharitis in children."

W. ZENTMAYER.

CONTRIBUTION TO THE PHYSIOLOGY OF ACCOMMODATION IN THE HUMAN EYE. E. SEIDEL, *Arch. f. Ophth.* 139: 513 (Nov.) 1938.

The author reports that in albinotic human eyes the equator of the lens can be made visible by transillumination of the iris with an ophthalmoscope equipped with a strong light source. Under these conditions the equator appears as a faint black circular outline concentric with and 1 or 2 mm. inside the limbus. This black circular outline can be seen to contract during accommodation and to dilate during relaxation of the ciliary muscle. This is the first observation made on normal,



intact human eyes which tends to show that the transverse (equatorial) diameter of the lens constricts during accommodation, as postulated by Helmholtz. Seidel's observation, therefore, supports Helmholtz's theory of accommodation.

P. C. KRONFELD.

### Retina and Optic Nerve

METABOLISM OF DETACHED RETINA. H. J. M. WEVE and F. P. FISCHER, *Ann. d'ocul.* 175: 817 (Nov.) 1938.

The normal retina lessens nearly all the vital colors, indicating oxidation-reduction; it possesses, therefore, a strong capacity for this faculty. This well known fact has never been definitely settled, particularly in regard to the actual ability of the living retina. It is this question that the authors have been trying to investigate in rabbits by following the technic of Redslob and Reiss in their work on the vitreous and that of Nordmann in his researches on the lens.

From their experiments, the authors conclude as follows: The normal retina, in contact with its pigmentary epithelium, has a potential oxidation-reduction ability which is very low ( $r_H$  16 to 18 by the electric method and less than  $r_H$  8.8 with indicators). The detached retina is much oxidized. Oxidation of the detached retina is due to a modification of its metabolism. In detachment it is no longer the glycolysis but the respiration which prevails. Glycolysis is possible only if the retina remains in contact with the pigmentary epithelium and the oxygen-reducing pads. A detachment provokes an interruption of this contact, with oxidation and inactivity of the glycolytic ferment and the abolition of vision. The reattachment produces the contrary phenomenon, increased glycolysis and the recuperation of vision.

S. H. McKEE.

NEUROSURGICAL OPERATIONS IN CERTAIN SYPHILITIC CONDITIONS WITH INJURY OF THE OPTIC NERVES. E. HARTMANN, M. DAVID and L. GUILLAUMAT, *Ann. d'ocul.* 175: 877 (Dec.) 1938.

The optic nerve, as is well known, is extremely sensitive to syphilitic infection, as is well exemplified by optic neuritis and atrophy of the optic nerve in cases of tabes. Apart from these cases of injury to the optic nerve, in which medical treatment only is indicated, there exist another group of cases in which the lesion of the optic nerve is related to neurosurgical intervention and is associated with syphilitic disease. The authors do not refer to cases in which a cerebral tumor is found in association with an old syphilitic lesion or to cases in which errors of diagnosis have been due to misinterpretation of the Wassermann reaction but to cases of true syphilitic lesions, as determined by papillary stasis or atrophy of the optic nerve, in which surgical intervention might be of benefit.

The authors do not believe that medical treatment alone is sufficient in such cases, but their observations show that in certain cases the stage for medical treatment has been passed by the time the patient is seen, so that intervention is useless. This may be due to a number of reasons. It seems to the authors, and it has been previously observed,

that antisyphilitic treatment has a much more beneficial effect after simple decompression.

Four cases are reported in detail with drawings and illustrations. A bibliography accompanies the article.

S. H. McKEE.

ANGIOID STREAKS AND PSEUDOXANTHOMA ELASTICUM. M. CORRADO, *Ann. di ottal. e clin. ocul.* 66: 801 (Nov.) 1938.

The author reviews the literature on angioid streaks and pseudo-xanthoma elasticum and reports 3 cases occurring in sisters. The cutaneous lesions of all 3 were noticed at an early age, while the ocular condition was not discovered until much later. The condition of the first patient was found at the age of 65, when visual failure had been noted for about a year. Aside from the typical streaks, both maculas were affected in this case, one showing a large triangular area of atrophy and the other a more diffuse area of pigment displacement. Vision was 1/20 in each eye. The condition of the other 2 sisters was discovered only at examination prompted by findings in their sister. One sister showed at 52 only the angioid streaks with normal central vision, while the other, at 64, showed partial involvement of one macula. All 3 showed characteristic cutaneous lesions. The author is inclined to accept Gronblad's explanation that the streaks represent defects in the lamina vitrea of the choroid which correspond to degenerative changes in the elastic tissue elsewhere in the body. Fundus pictures and a bibliography accompany the article.

S. R. GIFFORD.

TREATMENT OF CHOKED DISK (PAPILLEDEMA). M. BALADO and F. SORIANO, *Arch. de oftal. de Buenos Aires* 13: 649 (Dec.) 1938.

The authors first differentiate choked disk from swelling of the disk connected with certain intraocular and extraocular lesions, such as venous thrombosis, neuroretinitis and inflammatory lesions of the ocular membranes, considering it as constituting a syndrome composed of the three following elements: (1) an ophthalmoscopic picture showing swelling of the disk, raised above the retinal level, with venous dilatation and hemorrhage; (2) a visual disturbance consisting of an enlargement of the blindspot, with (in the initial stages) good visual acuity, visual field of normal limits and absence of a disturbance of adaptation, the mildness of this class of symptoms contrasting with the ophthalmoscopic picture, and (3) symptoms of intracranial hypertension (headache and vomiting).

This condition has to be distinguished from swelling of the disk in optic neuritis, in which the ophthalmoscopic picture may be identical.

Its production is due primarily to intracranial hypertension, the only other conditions in which its occurrence is discussible being arterial hypertension and syphilis.

As regards intracranial hypertension, this may be due to a localizable tumor or focal lesion or to conditions in which such a localization is impossible.

From a therapeutic point of view the authors lay stress on the importance of an exact localization and extol in this respect the results

obtained by Balado's iodopneumoventriculography, the technic of which is described in detail and exemplified by a number of cases.

Once the existence of a cerebral tumor or cerebral edema is established by this means, the following lines of treatment are advocated:

In cases of generalized cerebral edema, an early right temporal decompression is advised.

In cases in which a tumor is localized and can be removed, extirpation of the same is recommended; when it is not removable a decompressive operation should be done. In all these conditions lumbar puncture is contraindicated as extremely dangerous.

In cases of arterial hypertension with or without a renal lesion, a severe medical treatment (emunctories, diuretics, strict dieting and blood letting) is indicated. Here lumbar puncture, with proper precautions, has not the objections that pertain to the former class. Of late, section of the splanchnic nerves has been considered efficacious against the arterial hypertension.

In syphilitic cases, apart from the antisyphilitic treatment, and in cases in which this treatment has failed, lumbar puncture has been successfully employed for the relief of intracranial hypertension, and when this gives no permanent relief a decompressive craniotomy should not be delayed.

C. E. FINLAY.

CLINICAL AND PATHOLOGIC CHANGES IN TWO CASES OF ECLAMPTIC RETINITIS. C. KINUKAWA, *Arch. f. Ophth.* 139: 640 (Dec.) 1938.

A primipara, 27 years of age, had been well until the middle of the ninth month, when she was found to have a blood pressure of 155 systolic and 105 diastolic and moderate generalized edema. Without any marked further impairment of her general condition, one day she suddenly became eclamptic and died four hours after the first attack (three hours after a forceps delivery). At the time of the eclamptic attack the disks appeared pale with blurred outlines, surrounded by a zone of diffuse retinal edema. Outside of this zone of diffuse edema one could see some more distinct small areas of glassy retinal edema but no hemorrhages or white spots. The retinal arteries were moderately constricted. This constriction had been noticed before the patient became eclamptic and did not increase in intensity during the attack. Pathologically, the retina proper was found free of pathologic changes, but there were well circumscribed areas where the retina was separated from the pigment epithelium by a transudate rich in proteins. In these areas the pigment epithelium showed signs of pathologic secretory activity (Koyanagi) and degenerative changes (pyknosis and rarefaction of the nuclei). The choroid was hyperemic and contained hemorrhages. In the liver the pathologic alterations concerned principally the capillaries. Many of them showed acute thrombosis; others showed hyalinization. The liver cells around these capillaries exhibited degenerative changes which were partly due to pressure atrophy, the pressure having been exerted by ectatic capillaries, and partly due to ischemia. The kidney showed the picture of a severe toxic nephrosis. The second patient, 39 years of age, had had five uncomplicated pregnancies, but eclampsia developed during the sixth month of the sixth pregnancy. The highest blood pressure readings were 206 systolic and 130 diastolic. The urine contained albumin, cylinders and cells. At the time of the first eclamptic attack

the disks were pale with blurred outlines; the adjoining retina was slightly edematous, and the arteries were markedly constricted. About five hours after the first eclamptic attack the pregnancy was terminated by cesarean section. The patient died of cardiac failure four days later. On pathologic examination the retina proper was found to be normal. Again, there was subretinal transudation, which at one place had been poured into the space between the pigment epithelium and Bruch's membrane. The nuclei of the pigment epithelium also showed pyknosis and rarefaction. The choroid was in a state of passive congestion but free of inflammatory or degenerative changes of the walls of the vessels. In the liver necrosis of the parenchyma prevailed, whereas the capillaries were only slightly altered. The changes in the liver and kidneys in both cases were those usually seen in eclampsia. In the discussion of his findings the author stresses the absence of changes of the retina proper, which he considers a strong argument against the angiospastic origin of eclamptic retinitis. Following the ideas of his teacher Koyanagi, Kinukawa interprets the clinical and pathologic changes which constitute eclamptic retinitis as the result of the action of toxins on the pigment epithelium.

P. C. KRONFELD.

OCCURRENCE OF CYSTOID DEGENERATION IN THE PERIPHERY OF THE RETINA. F. KLEMENS, *Arch. f. Ophth.* 139:743 (Dec.) 1938.

Serial horizontal sections of 19 normal eyes removed at autopsy from patients of ages varying from 6 days to 77 years were studied. Cystoid degeneration was found to be present in every one of these eyes. The author believes that cystoid degeneration would be found in every eye if a sufficient number of sections were examined. The type of degeneration encountered in the eyes of children and adolescents was the same as that found in the eyes of elderly persons. There was no demonstrable relation between cystoid degeneration and the connective tissue layer located between the retina and the lamina vitrea which Reichling described in normal eyes. The cause of cystoid degeneration is still unknown. It should perhaps be looked on as a physiologic process which may become pathologically intensified in myopic eyes and in the course of the senile degeneration of the globe.

P. C. KRONFELD.

### Trachoma

EGYPTIAN OPHTHALMIA. F. W. LAW, *Brit. J. Ophth.* 23:81 (Feb.) 1939.

In an attempt to arrive at a solution to the questions "When and how did trachoma become a disease of considerable extent and importance in Europe?" and "What was the nature of the ophthalmia with which the European armies taking part in the Egyptian campaign of 1798 were stricken?", Law quotes the opinions expressed by authors of standard textbooks and by authorities on this particular disease. From his study of conflicting opinions, the author concludes: It is apparent that the Napoleonic campaign may fairly be blamed for the epidemic nature of trachoma in Europe in the years immediately after the cam-

paign. Factitious ophthalmia may have been rife, as Ferguson declares. The original infection may have been complicated by purulent ophthalmia. There is no doubt that trachoma was well known in Western Europe before the Egyptian campaign nor that the Irish recruits were heavily infected at the time of their enlistment. None the less, a consideration of the history of the disease leads one to the conclusion that the infection which was to prove in later years such a widespread and sight-destroying scourge was brought from Egypt.

W. ZENTMAYER.

TREATMENT OF TRACHOMATOUS PANNUS BY TRANSPLANTATION OF THE  
CONSERVED MUCOUS MEMBRANE FROM THE CADAVER. F.  
KOSTENKO, *Vestnik oftal.* 13: 500, 1938.

Kostenko accepted Filatov's theory that the transplanted mucous membrane acts as a "foreign tissue," which, while being absorbed, causes prolonged irritation of the cornea. The conserved mucous membrane, similar to corneal transplants used in additional transplantation, acts as a stimulator to the surrounding tissue, and it was deemed to be a good therapeutic agent in cases of severe trachomatous pannus. The technic of the operation was based on Denig's peridectomy with Filatov's modification of suturing the mucous membrane to the rectus muscles instead of to the conjunctiva.

Kostenko reports on a series of 9 cases. In 5 of these the mucous membrane of a cadaver's lip was transplanted at the upper portion of the cornea and sutured to the superior rectus tendon; in the other 4 cases a circular transplantation was done, the transplant having been sutured to the four rectus muscles. The transplant took. During the first week or two it was thickened; during the following few weeks it was gradually absorbed, being substituted by the conjunctiva of the host. The time of observation was about three months. The mucous membrane was conserved on ice at a temperature  $+2$  to  $+4$  C. from one to six days. The vision was improved in some cases from ability to count fingers to 0.1, to 0.5.

Thus the mucous membrane of the cadaver proved to be a favorable therapeutic aid in the treatment of severe pannus. Cosmetically, the operation was more advantageous than the Denig operation, because the transplant completely absorbed and only a fine scar could be seen at the site of the operation. The suturing of the transplant to the tendons of the rectus muscles makes the operative technic simple and shortens the time of the operation.

O. SITCHEVSKA.

### Tumors

INTRAOCULAR TUMORS. W. SUSMAN, *Brit. J. Ophth.* 22: 722 (Dec.) 1938.

The author gives the following summary and conclusions from a study of the material supplied by the department of pathology of

Manchester University, and the Royal Eye Hospital, Manchester, England.

"1. Intra-ocular tumors are essentially of three types:

- (a) Retinal tumors of neural origin.
- (b) Sarcomata of the choroid showing choroidal differentiation.
- (c) Melanomata of the choroid.

"2. Retinal tumors can be classified on a developmental basis analogous to the classification of Bailey and Cushing for glial tumors of the central nervous system. Accordingly, they can be divided into, neuro-epitheliomata, apolar spongioblastomata, polar spongioblastomata, neuroblastomata, and neuro-cytomata.

"3. Sarcomata of the choroid although they can be divided morphologically into the round cell and spindle cell types, and an occasional tumor of the mixed group, e. g., myxo-sarcoma, usually show differentiation into recognisable choroidal structures in parts. Hence they should be considered as malignant choroidomata.

"4. Melanomata are comparatively few and contain the typical branched melanotic cells.

"5. Pigment may be present in many retinal tumors and is therefore not diagnostic of a melanoma."

The article is illustrated.

W. ZENTMAYER.

RADON TREATMENT OF SECONDARY CARCINOMA OF THE CHOROID:  
POSTMORTEM OBSERVATIONS. P. J. EVANS, *Brit. J. Ophth.* 22:739  
(Dec.) 1938.

The terminal history of a case of metastatic carcinoma of the choroid, reported by the author in the September issue of the *British Journal of Ophthalmology* (21:496, 1938), is presented.

The author gives the following conclusions:

Radon therapy for secondary carcinoma of the choroid proved clinically effective over a period of two years and four months. During the major portion of this period good vision was maintained.

Ultimately failure of vision was due to intracranial complications involving pressure on the optic nerve.

Radon may prove to be of value as a curative form of treatment in an otherwise hopeless condition and should be considered as an alternative to enucleation of the eye.

The article contains a detailed account of the general and local post-mortem observations, with excellent illustrations. W. ZENTMAYER.

TUMOR-LIKE GROWTH OF THE RETINAL PIGMENT EPITHELIUM NEXT  
TO A METASTATIC CARCINOMA OF THE CHOROID. Y. KOYANAGI,  
*Arch. f. Ophth.* 139:732 (Dec.) 1938.

Koyanagi reports the case of a man aged 37, who two months before his death from a primary carcinoma of his right lung noticed a visual disturbance which was found to be due to an extensive retinal detachment without tears. The eye was removed and found to contain a

typical metastatic carcinoma situated in the choroid around the disk. In addition, another epithelial, probably benign, growth had arisen from the pigment epithelium overlying the choroidal tumor.

P. C. KRONFELD.

### Uvea

OPHTHALMOSCOPIC ASPECT OF TUBERCULOUS CHOROIDITIS VERIFIED HISTOLOGICALLY. BALDENWECK, H. TILLÉ and MOUNIER, Bull. Soc. d'opht. de Paris 50: 449 (Oct.) 1938.

The case reported is of interest because of the general etiologic factor and the possibility of comparing the fundus picture with the histologic picture. A woman of 20 years was admitted to the hospital for mastoiditis of the left ear and was operated on on the same day. Examination of the fundus, done because of the possibility of intracranial involvement, revealed two peripapillar nodules and another nodule slightly under and to the right of the macula. There was no complaint of a visual nature, and functionally the eye was normal. The fundus remained in status quo throughout the period of illness. A postotic meningitis ensued with choked disks. Staphylococci were found after death. Tuberculous lesions were found in the lungs, liver and spleen. A pathologic diagnosis of bacillary choroiditis was made. Necrotic nodules diffusely infiltrated with lymphocytes and containing the tubercle bacilli were found in the choroid. A clinical diagnosis of tuberculosis had not been entertained. Photographs of the fundus accompany the article.

L. L. MAYER.

BESNIER-BOECK-SCHAUMANN'S DISEASE AND UVEOPAROTITIS (HEERFORDT). W. BRUIN'S SLOT, J. GOEDBLOED and J. GOSLINGS, Acta med. Scandinav. 94: 74, 1938.

Six cases belonging to this syndrome are reported. Three of the patients had iridocyclitis, parotitis and positive hilus changes, and 1 of these had also a cutaneous lupus and another had edema of the skin; 2 had parotitis, positive hilus changes and cutaneous lupus. In 1 of these cases, however, the nature of the cutaneous lesion was in doubt; 1 had iridocyclitis, positive hilus changes and edema. The authors conclude, on the basis of a thorough study of their own cases and a consideration of the literature, that the uveoparotitis (Heerfordt) belongs to the Besnier-Boeck-Schaumann syndrome. They further believe that most likely tuberculosis is the cause and that the frequently negative reaction to tuberculin requires further investigation.

W. ZENTMAYER.

### Vitreous

PREPAPILLARY FLOATING BODIES. A. DRUAULT, Arch. d'opht. 1: 967 (Nov.) 1937.

The observation of an opacity of the vitreous in front of the papilla is common and conforms to a fairly well defined clinical picture. Druault

presents some statistics which indicate that this opacity appears between 50 and 70 years of age in persons with hyperopia, emmetropia and low myopia and from the age of 25 upward in persons with high myopia. With the ophthalmoscope this opacity is seen as single and in an otherwise clear vitreous, unassociated with hemorrhage or inflammation. It is found exactly in front of the disk. Parallax movement shows it to be some distance from the retina, sometimes in the center of the vitreous. Its relation to detachment of the retina is discussed, the opinion being expressed that there is some connection. According to Baenziger and Vogt there is always a posterior detachment of the vitreous and the opacity is a fragment of the posterior limiting membrane. The author is of the opinion that this opacity of the vitreous is usually the result of the rupture of the central canal of the vitreous. The opacity has been described under various titles in the literature by de Wecker, J. Galezowski, Bailliart, Vogt and Baenziger. The author believes that in the cases of all of these authors the opacity is essentially of the same nature.

S. B. MARLOW.

RESEARCH ON THE ORIENTATION OF THE NORMAL STRUCTURAL MEMBRANES OF THE VITREOUS. A. VOGT, H. WAGNER and M. SCHNEITER, *Klin. Monatsbl. f. Augenh.* 101:235 (Aug.) 1938.

Structural membranes of the vitreous are fine densified formations, which are not of a histologic nature; they give the optical impression of movable reflecting membranes of an extraordinary minuteness. Redslob, Gullstrand, Erggelet and Vogt reported on these formations in the anterior portion of the vitreous. The vitreous of 30 youthful patients was examined with the slit lamp in a vertical and a horizontal position of the head. In each case the frontal structural membranes of the anterior portion of the vitreous arranged themselves promptly by force of gravity. They seem to be suspended on what Salzmann called the basis of the vitreous. The authors disagree with Redslob, after finding a support of the views of Gullstrand and Erggelet.

K. L. STOLL.



# Society Transactions

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## AMERICAN OPHTHALMOLOGICAL SOCIETY

FREDERICK TOOKE, M.D., *President*

*Seventy-Fifth Annual Meeting, Hot Springs, Va., June 5-7, 1939*

EUGENE M. BLAKE, M.D., *Secretary*

AFTER-CATARACT. DR. ALFRED COWAN and DR. ROBB McDONALD, Philadelphia.

This paper will appear in full, with discussion, in a later issue of the ARCHIVES.

AN INVESTIGATION OF EXPERIMENTAL CATARACTS IN THE ALBINO RAT: CLINICAL IMPLICATIONS. DR. ARTHUR M. YUDKIN and HARRIET A. GEER, PH.D. (by invitation), New Haven, Conn.

This paper will appear in full in a later issue of the ARCHIVES.

FAMILIAL PROGRESSIVE JUVENILE CATARACT. DR. ROBERT VON DER HEYDT, Chicago.

During the past five years a complicated type of progressive cataract developed in each eye of 3 of 5 siblings. They were 2 boys aged 11 and a girl aged 21. In addition, there were in the family 3 children of younger ages, 8 in all.

Careful ophthalmoscopic and slit lamp examination revealed no evidence of an ocular pathologic process. Physical examinations disclosed no constitutional toxic factors. All 3 children were operated on without complications and now have normal vision.

### DISCUSSION

DR. J. W. JERVEY, Greenville, S. C.: The subject of familial cataract is always interesting, and Dr. von der Heydt has made some studies as to the causation which makes it even more so. Beginning in 1915, I saw a father, 3 sons, 3 daughters and 1 grandchild, the child of one of the daughters, with infantile cataracts. One cataract was congenital, and the others appeared at ages from about 5 to 14 years, usually forming quickly. Six of the patients were operated on by me, by discission. The best result was improvement of vision to 20/15, and the poorest result was vision of 20/40 with correction. In none of these cases was there any pathologic process in the fundus. Naturally I sought the cause. Was it diabetes? Was it uncinariasis? Apparently not. The father was the main stem and could trace no serious ocular trouble in his family connection. I am satisfied that Dr. von der Heydt has made an entirely reasonable observation when he attributes the cause of these familial cataracts to a loss of calcium-phosphorus balance in the blood and tissues.

DR. ROBERT VON DER HEYDT, Chicago: In spite of all this laboratory enthusiasm, one must still differentiate between whether these children received the wrong kind of food or whether they had hereditary parathyroid deficiency. Dr. Jerver's cases seem to bring up the question as to whether these cataracts are recessive or dominant. Mine seem to be recessive, while his seem to be dominant, if I understand the difference.

LATTICE DYSTROPHY OF THE CORNEA IN A FAMILY. DR. RALPH I. LLOYD, Brooklyn.

There has been much confusion about the hereditary dystrophies, and the names of Groenouw, Dimmer, Haab and Fuchs have been attached to cases with vague differentiation. The German government has been conducting studies of all types of hereditary disease with the view of eliminating these from the national life.

As a result of extensive studies, it now becomes apparent that there are only three forms of hereditary corneal dystrophy and that one form never passes over into another. The granular and reticulate forms are dominant, while the macular form is recessive. The reticulate, or lattice, dystrophy can be diagnosed positively with the slit lamp at an early stage, while the other two forms may require extended observation. A family consisting of a mother and 3 or 4 children has been under observation for several years, and the hitherto unmentioned but characteristic attacks of photophobia, lacrimation and superficial ulceration have been a feature in each. It is evident that the common conception of corneal dystrophy as a painless, chronic degeneration needs revision. In some family groups these attacks of unknown origin are much more pronounced than in others. Lattice dystrophy requires differentiation from herpes in the early stages and old trachoma and pemphigus (essential shrinking of the conjunctiva) in the late stages.

DISCUSSION

DR. ROBERT VON DER HEYDT, Chicago: I should like to call attention to some of the illustrations that have been published of these three now accepted types of corneal dystrophy. I wish to emphasize the fact that dystrophies are not subject to inflammatory changes unless the inflammatory changes are secondary in nature and happen to be occurring, irrespective of the dystrophy as a basis. (The types of dystrophy were exhibited by means of lantern slides.)

The granular type, first described by Groenouw, and later by Fleischer and Fair, is discoid in the middle and has clear spaces.

The lattice type has characteristic features, but some of the formations have been found in the Groenouw type.

In some corneal dystrophies there are superficial and deep lesions, sometimes called the "spotted" type, and which Dr. Lloyd called the "macular" type. If the condition progresses, it leads to blindness. It perhaps evolves into the Groenouw nodular type.

In addition to these three well known types, there are two other types that may be confused with them. There is the nummular, or the Dimmer, type, which is characterized by disks and is called nummular because the lesions resemble coins. There is also the Salzmann type

of dystrophy, which is monocular and results from inflammation. This type is also called keratitis fibrosa by Vogt, who has published one illustration of it. The characteristic feature is that the vascularization does not extend into the lesion—it surrounds it.

DR. ALLEN GREENWOOD, Boston: Dr. Everett Goar is the author of an excellent paper on corneal dystrophy (Dystrophy of Corneal Endothelium [Cornea Guttata], with Report of Histological Examination, *Am. J. Ophthalm.* 17:215-221 [March] 1934). In 1930 I published a paper on lattice dystrophy (Lattice Keratitis: Studies of Four Cases Observed in One Family, *Tr. Am. Acad. Ophthalm.* 35:248-258, 1930) in which I described a typical form of lattice keratitis in an elderly woman and 3 of her children. The mother was over 60 and had lost the sight of both eyes following ulceration, which I think was implanted on the dystrophy. Dr. Verhoeff removed the entire front of the cornea in 2 or 3 of these cases and obtained great improvement in vision and apparently some stay in the progress of the disease.

DR. F. H. VERHOEFF, Boston: The first of these patients had been seen for a number of years in the clinic, and her condition had gradually become worse. She had a lattice type of dystrophy, and the eyes became irritable and the vision much reduced. The opacity seemed to be superficial and was dissected off of one eye. In such cases the cornea is abnormally thick and one can take a great deal off. The patient obtained great improvement in vision and was so relieved from the irritation that she insisted on having the same operation on the other eye, which likewise afforded her relief from the irritation. Three members of the family were operated on and all obtained improvement. Whether the operation is going to check the progress of the dystrophy or not is not known as they have not been observed recently.

DR. E. V. L. BROWN, Chicago: I wish to call attention to an article written by Salzmann on neurodystrophy in glaucoma (Die glaukomatöse Hornhautentartung, *Arch. f. Ophthalm.* 139:413-464 [Nov.] 1938). Seventy per cent of 165 eyes studied anatomically showed this type of neurodystrophy. It consisted of a proliferation of corneal nerve tissue brought out by a modification of Held's stain. Salzmann referred to a previous description of neurodystrophy in glaucoma by Ernst Fuchs, but he did not refer to any one else who has considered this condition.

DR. RALPH I. LLOYD, Brooklyn: I want to present three illustrations from the literature. The first two are from Groenouw's original articles which appeared in 1890 and 1898, and they point out the accepted distinctions between the different types of dystrophy. Groenouw saw the 2 cases illustrated in 1890 and again in 1898. The first case was one of granular dystrophy. The striking feature he pointed out in this type is limitation to the central area of the cornea, a clear rim being left outside; despite the fact that this type of dystrophy develops markedly in the aged, the tissue in between the individual spots remains clear, so that affected persons, according to reports, can continue such work as farming. The second case was one of what is now referred to as the macular form, which even in the earlier stage

involves the entire cornea. This is the worst type of all. The patients lose their vision almost completely at an early age.

The third illustration is from an article by Haab, in which lattice dystrophy is described.

I wanted to show these particular illustrations because the picture still holds today.

INJECTION OF AIR IN MAINTAINING FILTRATION AFTER CORNEO-SCLERAL TREPHINING IN GLAUCOMA. DR. J. A. MACMILLAN, Montreal, Canada.

This paper will appear in full, with discussion, in a later issue of the ARCHIVES.

PSYCHOSOMATIC INTERRELATIONS: THEIR THERAPEUTIC IMPLICATIONS IN GLAUCOMA. DR. MARK J. SCHOENBERG, New York.

This paper will appear in full, with discussion, in a later issue of the ARCHIVES.

CHANGES IN THE VISUAL FIELDS AFTER SATISFACTORY FILTRATION OPERATIONS FOR GLAUCOMA. DR. JOHN W. BURKE, Washington, D. C.

This study is based on a survey of office records in an effort to evaluate the changes in the visual fields after a filtration operation for glaucoma. Only those cases were considered in which the changes in the visual fields were carefully recorded.

In all the cases in which operation was performed the tension was high and the changes in the visual fields were progressive or could be expected to be progressive from the experience of the patient with the other eye. A filtration operation was done in all cases. The period of observation since operation has been at least five years, and in no case has the intraocular tension since operation risen above 26 mm. (Schiötz). The cases were divided into two groups: those in which there had been no change or only a slight increase in the visual fields and those in which the fields had continued to diminish in size.

#### DISCUSSION

DR. SANFORD GIFFORD, Chicago: Perhaps a little more emphasis should be placed on the cases of glaucoma in which the visual fields remain unaltered after operation. One sees statements in the literature that glaucoma is a progressive disease and that it progresses in spite of successful operation. Such statements have a bad effect on patients with glaucoma, and this record of slight field defects in only 50 per cent of the cases is a rather important one. My experience has been a little different from Dr. Burke's, in that I think the cases in which I have seen the changes progress after so-called successful operations for glaucoma have been the cases in which the tension has not been very low but has varied on the upper limits of normal. This is an argument in favor of the filtration operations, which bring the tension down to a relatively low point, rather than cyclodialysis, which does not often bring it down so low. I do think some of the changes which occur in cases in which the tension is really low can be explained on the basis of arterio-

sclerosis of the retinal vessels. I have noticed the small size of the arteries in some cases in which changes in the visual fields have occurred.

DR. LUTHER C. PETER, Philadelphia: I have not seen many instances of retrogression of the visual fields in cases of low tension but rather in those in which the tension stands near the upper limit of normal. There are types of glaucoma simplex which might be called malignant. They occur in patients who are hardly neurotic but are nervous and subject to depressing emotions. Outwardly they may seem calm and unperturbed. Notwithstanding this, even after a well performed filtration operation there may be an inadequacy of the drainage due to factors created perhaps by suppressed emotions, worry, grief and excitement, so that in a certain number of cases I believe one must expect to have an increase in the contraction of the fields. Taken as a whole, it seems to me that a well performed sclerocorneal trephination offers a future for these patients which is well worth attempting, even when the central field is seriously involved.

DR. ALGERNON B. REESE, New York: I wish to mention some results of an analysis of cases of chronic primary glaucoma which merely confirm Dr. Burke's findings. In my series there were 102 eyes classified as having advanced glaucoma in which the corresponding fields of vision were contracted to more than 30 degrees in any one meridian and all blindspots were enlarged to over 15 degrees. All were subjected to trephination, and subsequent observations were made over a period of five years or longer. Twelve of the 102 eyes were rejected because the fields of vision had contracted beyond fixation, with loss of central vision before operation, so that it was difficult to determine the question of progression after operation. Of the remaining 90 eyes, 65, or 72 per cent, showed progressive contraction of the fields after operation. Of these 65 eyes in which the fields progressively contracted, 39, or 60 per cent, had normal intraocular tension at numerous times over the follow-up period, which is a confirmation of Dr. Burke's findings. This would indicate that if the vascular changes occasioned in the retinal vessels by the increased intraocular pressure producing the contraction of the peripheral field have reached a certain degree or have gathered a certain momentum, so to speak, they continue to progress, thus producing progressive field defects in spite of normal intraocular pressure. This fact is a strong argument in favor of operating early in cases of primary glaucoma, before this vascular condition gathers sufficient momentum to progress regardless of the successful reduction of the intraocular pressure.

There is one other finding which I believe is proper to mention here, and that is that 25 eyes among those with advanced glaucoma showed progressive constriction of the visual fields to the point of so-called telescopic fields and then showed no further progression over the follow-up period. Dr. Burke had a similar case. The central field remained in 12 instances in spite of the fact that the intraocular pressure was above normal. Ten of the 25 eyes retained central vision, and 5 of these even showed increased intraocular pressure over the follow-up period. The explanation for this seems to be that in some eyes the macular region receives sufficient nutrition from the underlying choroid to enable it to function independently of the retinal blood supply altered by the glaucoma.

# SOCIETY TRANSACTIONS

DR. S. J. BEACH, Portland, Me.: It seems to me that Dr. Burke's results, far from being discouraging, are very encouraging and he ought to be proud of them.

There are two points, I think, which might be made. On the basis of our experience, Dr. MacAdams and I believe that tension of 26 mm. of mercury is a rather high normal, and if we cannot get the tension down nearer 20 we feel rather apprehensive about the outcome. The second point is that there seems to be an irresistible temptation to rate the postoperative results according to the office findings. The tension of eyes that have been operated on for glaucoma frequently is found to vary in amount, as is commonly seen in some cases of glaucoma before operation, and that fact should be kept in mind in evaluating the results of operation.

MR. H. M. TRAQUAIR, Edinburgh, Scotland: Dr. Burke's paper represents a great deal of hard work, and it is the kind of work of which more is needed. As far as I know, it is the only paper which has yet been presented in which the results of a large series of cases have been collected over a number of years. Most of what I might have said has already been stated by the previous speakers. I think a tension of 26 mm. of mercury, even though the average may be 17, is not really quite safe and makes one a little apprehensive. The point to which I should like to draw attention is one which has not been mentioned. It concerns the character of the changes in the visual field which occur when the postoperative tension is quite low, 8 or 10 or 12 mm. of mercury. Some patients, especially those with tension of about 12 mm. of mercury, seem to be altogether well, yet one finds a progressive loss of visual field. I find that with progressive loss of visual field after an operation for glaucoma which appears to be successful, that is to say, with tension around 25 mm. or thereabouts, the field continues to be of the glaucomatous type. On the other hand, if one finds loss of field occurring when the tension is low, the defect takes the form of a peripheral contraction and produces a telescopic field, which has been mentioned and which may continue for a number of years. There are two types of postoperative fields: one in which the original glaucomatous type of field continues to progress and another in which quite a new factor appears to be introduced, namely, that of severe peripheral contraction. In such a case the result may be a bit disappointing. It occurs in cases in which the tension is low and yet has come to be associated with the complications of postoperative hypertension. The only explanation I can suggest for this type of field is that a cicatricial process has been started in the head of the optic nerve and that this has continued to progress, even though the tension is lowered. It is similar to a cicatricial process which starts in papilledema. If operation is not done soon enough, the defect will progress, and then loss of vision will occur, although the intraocular pressure is reduced. This is only a hypothesis, but it seems to me to be the only feasible explanation.

DR. WILLIAM H. CRISP, Denver: In the consideration of results after operations for glaucoma it may be well to bear in mind that symptoms of glaucoma may persist after tension is lowered to normal. I have seen several cases in ordinary private practice in which there were undoubtedly glaucomatous changes, as indicated by the various symptoms, and yet the tension remained normal. Furthermore, I

concur in the opinion of other speakers in not being satisfied with tension that is within the supposedly normal limits, the upper limit being stated as 28 mm. of mercury (Schiötz); I do not feel happy about the patient unless his tension does not go above 20 mm. of mercury.

SOME PROBLEMS IN PERIMETRY. MR. H. M. TRAQUAIR, Edinburgh, Scotland.

This paper will be published in full, with discussion, in a later issue of the ARCHIVES.

FINAL OCULAR RESULT IN A CASE OF ACUTE CEREBELLOPONTOBULBAR POLIOENCEPHALITIS, TWENTY-SEVEN YEARS AFTER THE ACUTE ATTACK. DR. EDWARD A. SHUMWAY, Philadelphia.

A patient with acute myeloencephalitis involving the cerebellar tracts, medulla and pons was under observation twenty-seven years. All sensory symptoms disappeared, but motor defects were permanent. Ocular palsies were successfully corrected by the use of prisms.

ROUND MACULAR EXUDATE. DR. ARTHUR J. BEDELL, Albany, N. Y.

The distinctive shape of round macular exudate is found in a great many pathologic processes, from preretinal and retinal edema to organized scars. Illustrative case histories, colored photographs of fundi with fresh exudate and juvenile and senile macular degenerations formed the basis for clinical deductions and a discussion of the differential diagnoses.

CERTAIN RETINOPATHIES DUE TO CHANGES IN THE LAMINA VITREA. DR. SANFORD R. GIFFORD and DR. BEULAH CUSHMAN, Chicago.

This paper will be published in full, with discussion, in a later issue of the ARCHIVES.

METASTATIC CARCINOMA OF THE IRIS. DR. MARY KNIGHT ASBURY (by invitation) and DR. DERRICK VAIL, Cincinnati.

A review of the ophthalmic literature reveals but 6 reported cases of metastatic carcinoma of the iris. To this series is added the following case, the only one in which the primary tumor as well as the entire globe was available for study.

A married woman 49 years old had her right breast removed in August 1937, because of tumor. Twelve days later she noticed that her right eye was inflamed. The vision became somewhat blurred, and a diagnosis of iritis was made. One month later she noticed a small spot in the iris, temporal to the pupil. This slowly enlarged. Examination on November 17 showed a coral-like, spongy growth in and on the iris, between 8 and 12 o'clock, flattened by the posterior surface of the cornea. There was flocculent debris in the floor of the anterior chamber, on the posterior surface of the cornea and on the anterior capsule of the lens. Tension measured 65 mm. of mercury (Schiötz). The vision was almost normal. The eye was removed the next day. Histologic

examination showed compressed spindle-shaped carcinomatous cells, identical with those seen in tissue from the breast and axillary lymph nodes. Death occurred on Feb. 2, 1938, from metastasis to the brain and stomach.

#### DISCUSSION

DR. ROBERT VON DER HEYDT, Chicago: I should also like to present an extremely rare instance of ocular metastasis in a case of abdominal carcinomatosis in a woman 55 years of age. The lesions of the iris, at 11 and 7 o'clock, respectively, have appeared from the root of the iris during the past month. The normal color of the iris is bluish green, while the lesions are orange. The slit lamp shows the tumors to be more white and covered by large vessels. The surfaces of the growths are covered by whitish irregular-shaped flakes. These seem to be shed by the growth, as there is quite a deposition on the posterior corneal surface simulating cyclitic deposits. The aqueous is clear with the exception of a few of the circulating flakes. There is no pain, ciliary injection or tension. On microscopic inspection after freezing, the upper mass was 2.5 by 6 mm. as it arose from the ciliary body and iris. A careful examination of the fundus showed no evidence of the choroidal metastasis later found on section. The tumor in the iris was the first clue to the character of the abdominal pathologic process.

Dr. Georgiana Dvorak-Theobald's report is as follows:

The tumor invaded not only the iris but the ciliary body. It was composed of large, pale-staining, cubical cells, suggestive of the watery cells found in tumors of the kidney and adrenal gland. There were strands of cells which anastomosed freely with one another; also cells arranged in tubular formations. These were supported by a delicate stroma with thin-walled blood vessels. Some sections showed groups of cells on the anterior surface of the iris and the posterior corneal surface.

Similar minute formations were found in the choroid; they were small enough not to disturb the retina.

Owing to the fact that there were no symptoms of sexual derangement, this tumor is suggestive not of metastasis from an adrenal growth but from a hypernephroid carcinoma.

DR. ALGERNON B. REESE, New York: I should like to mention another case of metastatic carcinoma to the iris which has some points in common with the case reported by Dr. Asbury and Dr. Vail. A man of 60 was prompted to consult a physician because of a lump in the right axilla. Biopsy of this lump showed carcinoma of a lymph node. An effort to determine the primary site was unsuccessful. In the course of a month sudden pain developed in the right eye, and on examination I found the intraocular tension to be 65 mm. of mercury (Schiötz), and in the iris, on the temporal side, there was a grayish mass. There were also some deposits on the posterior surface of the cornea. In the course of two months the patient died, and at autopsy the primary site was found to be in the stomach, in spite of the fact that the studies of the gastrointestinal tract were negative. At autopsy, the eye showed a mass of carcinomatous tissue in the iris with tumor cells in the anterior chamber along the cornea. There was a rather marked inflammatory element in the eye, due apparently to necrosis of the carcinoma. This



is an instance of a metastatic lesion in the eye becoming manifest before the primary tumor. I have had 2 other instances of a metastatic lesion to the eye manifesting itself in the choroid before the primary site was known; in 1 case the metastatic lesion was bilateral; the primary site in that case proved to be the thyroid.

DR. DERRICK VAIL, Cincinnati: We are grateful for the additional 2 cases, 1 by Dr. von der Heydt and 1 by Dr. Reese. They add an additional fact that such tumors of the iris apparently cast off debris, which is deposited on the posterior surface of the cornea and fills up the anterior chamber.

Another interesting thing which the discussants brought out, unconsciously, I think, is the bilateral character of the clinical appearance of these tumor masses. The lesion is not difficult to recognize when it is fully developed.

MULTIPLE MYELOMAS. DR. H. MAXWELL LANGDON, Philadelphia.

The first symptom of multiple myelomas in the case reported here was bilateral palsy of the external rectus muscle with later left retrobulbar neuritis.

In a woman 47 years of age, with a negative ocular history except for an error of refraction, pain developed in the head in August 1937. It was worse on the right side, but she did nothing about it till October 1937, when diplopia developed over the whole right field, due to weakness of the right external rectus muscle. General neurologic examination gave negative results. This included examination of the spinal fluid. One month later weakness of the left external rectus muscle developed, making the condition bilateral. The patient was under the care of her family physician, Dr. C. Harold Kistler, and was also seen by Dr. Francis Sinkler, who concurred with a tentative diagnosis of encephalitis, as no symptoms could be found pointing toward any other definite diagnosis. A roentgenogram showed a condition which was diagnosed as multiple myelomas through all the long bones and the skull. In April a definite retrobulbar neuritis of the right eye developed with a large absolute central scotoma. The patient had multiple fractures of the ribs and of all long bones while lying in bed without any trauma, and died in October 1938.

Multiple myeloma is a rare condition and seldom affects the skull. Of 12 cases in the Montefiore Hospital, only 2 showed involvement of the skull, the long bones and vertebrae being most frequently affected. Ocular symptoms are a distinct rarity. The case here reported is unusual in this aspect.

#### DISCUSSION

DR. F. H. VERHOEFF, Boston: Here again I did not notice any reference to a case of multiple myelomas of the orbit and sternum that I reported a good many years ago. It may have been the first case reported. Dr. Langdon did not refer to any other reports either, so I do not suppose I should take offense. He is going to report the case in the *Transactions of the American Ophthalmological Society* and in the *Journal of Medical Research*. My purpose in speaking is not to call attention to this fact but to the fact that I think I discovered something new about these tumors at the time. In the typical case the cells are

almost like plasma cells. They cannot be differentiated from plasma cells on ordinary examination. All of them are not typical, but those in my case were. I found a difference in the plasma cell that definitely differentiated the nucleoli, and I worked out a stain to bring out this difference. Since then I have noticed that even the most noted pathologists in the field of tumors of the eye can fall down on the diagnosis of this condition. These pathologists have a thousand tumors to examine while I do not have so many, and I suppose that makes it more likely for me to make a correct diagnosis. The growths in this particular case were typical multiple myelomas, and a noted pathologist called them something else, but he admitted his error and apologized for the mistake when I called his attention to the fact that they were multiple myelomas. This shows that these tumors can be easily mistaken by most general pathologists, particularly when the cells do not look exactly like plasma cells. There is a tumor of the conjunctiva, a plasmoma, which is probably an inflammatory tumor, in which the plasma cells do not show the nucleoli; this type of tumor is very responsive to roentgen irradiation. I do not remember whether roentgen irradiation was used in the case I referred to. I have an idea I had another patient with a tumor of the orbit who was treated with roentgen rays. Whether it was the same condition or not I do not know; anyway, roentgen treatment was beneficial and kept the man alive for a good many years. I do not know whether he is alive yet. One would expect, on account of the character of the cells, that roentgen or radium treatment would be beneficial in cases of multiple myelomas.

KERATOMALACIA AND CYSTIC FIBROSIS OF THE PANCREAS. DR. RICHARD C. GAMBLE, Chicago.

Recent postmortem studies indicate that vitamin A deficiency causes keratinizing metaplasia of the epithelium in the lacrimal and salivary glands, in the lungs and in the pancreas. Important changes occur in the pancreas which may interfere with the digestion of fat, and for this reason the fat-soluble vitamin A may not be utilized. Typical keratomalacia and other signs of avitaminosis A developed in an infant at an early age in spite of some intake of vitamin A. A twin brother was fed the same diet and remained well. The keratomalacia healed following the local use of percomorph liver oil and cod liver oil, but the general use of the same preparation was without benefit. Postmortem examination revealed cystic fibrosis of the pancreas which was thought to be primary and to be the cause of the avitaminosis A.

DISCUSSION

DR. WILLIAM ZENTMAYER, Philadelphia: I believe the following observation is of sufficient interest to mention. Forty-five years ago I was asked to see an infant who had keratomalacia. The child lived but a short time, and at postmortem examination it was found there was a congenital absence of the pancreas. I believe this is the only case of the kind on record.

DR. ARTHUR M. YUDKIN, New Haven, Conn.: This impressive report of a nutritional deficiency leads me to present a picture which has been described so frequently by the laboratory worker on vitamin A deficiency. When animals with vitamin A deficiency are given the vitamin A missing in their diet, the ocular picture will frequently clear up, but the rest of the manifestations, such as the disturbances in the lung, the kidney and pancreas, frequently do not repair themselves. That is probably due to the fact that vitamin A can no longer help those cells which have been destroyed. I was much impressed that Dr. Gamble reported that the corneal lesion had responded to local treatment with vitamin A. I have not had as much luck with that sort of treatment in experimental animals. I have, however, cured corneal lesions by just adding vitamin A to the diet. Dr. Gamble brings out an interesting point, that these deficiencies are not just single deficiencies but are probably always multiple in nature.

DR. J. E. WEEKS, Portland, Ore.: This is a subject that has interested me much indeed. In the early years, from 1882 to 1892, I saw a number of infants with keratomalacia. At that time I was interested in bacteriology, and the examination of the secretions of the epithelium in these cases invariably showed pure cultures of *Bacillus xerosis*, so-called, and in 1 case I was able to do an autopsy. The condition became established in the first two or three months, at which time these infants invariably died. Bacteriologic examination of the various organs of the body showed a pure culture of *B. xerosis* in all. This condition is the same that is found in adults—so-called xerosis conjunctivae. I do not suppose that many of the ophthalmologists here have ever seen a case in adults. The condition is characterized by the appearance of a triangular patch at the margin of the cornea, in the temporal portion. I had 1 patient from a prison in Cuba in whom this occurred. In infants the condition is due to lack of the proper vitamin. The whole development of the cause of this condition has, of course, occurred since the observations that I made years ago.

LINDAU'S DISEASE: REPORT OF SIX CASES WITH SURGICAL VERIFICATION IN FOUR LIVING PATIENTS. DR. ALEXANDER E. MACDONALD, Toronto, Canada.

This paper will be published in full with discussion, in a later issue of the ARCHIVES.

PLEXIFORM NEUROFIBROMATOSIS (RECKLINGHAUSEN'S DISEASE) OF THE ORBIT AND GLOBE: WITH ASSOCIATED GLIOMA OF THE OPTIC NERVE AND BRAIN; REPORT OF A CASE. DR. FREDERICK ALLISON DAVIS, Madison, Wis.

This paper will be published in full, with discussion, in a later issue of the ARCHIVES.

EVISCEATION OF THE GLOBE WITH SCLERAL IMPLANT AND PRESERVATION OF THE CORNEA. DR. FRANK E. BURCH, St. Paul.

Since the conventional procedures for enucleation and evisceration of the contents of the globe often leave much to be desired from the cosmetic standpoint, a method of implantation of a lead-free glass or

gold sphere in the scleral shell with preservation of the cornea has been carried out in a series of 21 cases. The results surgically and cosmetically have been most satisfactory. The principal objection to the procedure is loss of the specimen for histologic study and the necessity of longer hospitalization.

#### DISCUSSION

DR. SANFORD GIFFORD, Chicago: I am glad Dr. Burch has called attention to the value and to the lack of danger involved in leaving the cornea intact in evisceration of the globe. Dr. Zentmayer, with his wonderful memory, reminded me yesterday that some years ago my father described an operation similar to that described by Dr. Burch, but I cannot remember the details of his technic. I do wish to remind the members of the society of the great practical value of my father's simple evisceration of the globe and of the great superiority of this operation over the old method in which the cornea was removed. I think this is one of the most useful of the practical procedures that my father ever devised. It consisted of making an incision across the middle of the cornea, out into the sclera, about 2 mm. on either side, so that the lips of the wound may be everted. After the contents of the scleral shell are removed and bleeding has stopped, the inside of the eye is clearly visible, so that all the uveal tissue can be removed. Sutures are not inserted. A large tonsil swab is put under the lids to compress the cornea and is left there for forty-eight hours. The chemosis which follows this operation, as Dr. Burch has said, is usually marked, but it can be minimized or sometimes avoided altogether by the constant use of a rubber glove containing cracked ice, which is applied to the closed lids almost constantly for the first three days. If this is done, this period of chemosis which Dr. Burch has described as tenonitis passes off, and after that there is little chemosis.

In my experience the cosmetic results obtained by leaving the scleral shell and cornea intact are as good when the implant is made into the scleral shell, and the motility is much better than is obtained by an implant in Tenon's capsule. The capsule shrinks until it is about as big as one's little finger nail. It becomes opaque and insensitive when simple evisceration is done. A reform eye is usually worn over such a stump, which becomes full of blood and connective tissue; makers of artificial eyes consider it ideal and they prefer it to the stump left by an implant in Tenon's capsule.

DR. ALEXANDER E. MACDONALD, Toronto, Canada: I believe that this may be a dangerous procedure. As a surgeon, I feel that any time it is necessary, and one has to admit that at times it is, a consultation should definitely be had with some competent physician. I do not believe that one can assume safely that one can completely remove the uvea, and I feel that one is assuming, when one does an evisceration, a surety of diagnosis that is not warranted by my experience as a pathologist. I do not think one should sacrifice the safety of the patient in many cases, for a diagnosis is essential after surgical procedures. No surgeon would destroy his evidence, and I am of the opinion that one is taking a liberty if one does destroy the evidence that may be obtained by the pathologic examination.

As far as a good cosmetic result is concerned, I believe that the makers of artificial eyes can insure that if they will use the recent advances that have been made in that field.

DR. A. C. KRAUSE, Chicago: For a great many years I have been doing the Dimitry operation, or a modification of it, with excellent results. I am sure I have not lost 25 per cent of the prostheses. In talking with Dr. Burch he said that it is most essential that the hemorrhage should be stopped. There are five prominent bleeding points, and with the Dimitry operation it is easy for blood to escape where the window is cut out of the sclera with the optic nerve. I think that the great objection that most operators have to the method of Dimitry is that the hemorrhage bothers them in taking out the scleral window. I have modified the technic of Dimitry and made it so much easier and quicker that the errors of that part of the operation have been eliminated.

I know that makers of artificial eyes agree that this form of prosthesis—a gold ball in the scleral cavity—gives a much better motion to the artificial eye. They do not like the operation of implanting a large ball in Tenon's capsule because of the inability of the ball to stay put in one particular place or to stay centrally. The use of the shell eye after modification of the Dimitry technic has been most satisfactory. I do not see what the object is in retaining the cornea. What difference does it make? Every one knows that there is tremendous swelling after this operation, but it does not amount to anything; it always disappears without trouble. This operation has been most satisfactory in my hands. I have had 2 patients who had been shot and the sclera torn. I have put in catgut sutures and gone ahead with the operation in the usual way, and the results have been satisfactory.

DR. P. C. JAMESON, Brooklyn: I think that in the future I will do the operation described in preference to Mule's operation, or any modification of it. I used the Mule technic in a number of cases in my early experience and was not pleased with the result because there were so many extrusions. The sclera does not lend itself well to this procedure. The advantage of the procedure described by Dr. Burch is that a glass or gold ball is implanted in such a way that extrusion is not likely to take place; the conjunctiva, sclera and cornea as well as the lid, which makes some pressure, protect the implant. One of the objections to the ordinary enucleation which Dr. Krause has just mentioned is the migratory condition of the implant. I have not seen many extrusions with ordinary enucleation. There is a semiextrusion which occurs early due to giving way of the capsule at the anterior pole.

I do not quite understand Dr. Burch's technic; that is, whether the incision is, as I understood it, around the cornea. I am not going to modify his operation. I do not believe in changing a suture and modifying an operation and then calling it one's own, or one's modification, but I should like to hear from Dr. Burch as to whether a vertical incision might not be better than the sclerocorneal incision which he makes, that is, which I understand he makes. One of the great safeguards to extrusion which can be traced to Mule's method is the separate suturing of the muscle cone and the conjunctival aperture. The cone underneath the conjunctiva is stretched by an assistant who has grasped it at both sides with a forceps, drawing it into, say, a linear transverse aperture, and then bringing it together by a running suture. The round conjunctival aperture is separately stretched in the same way into a vertical linear aperture and also brought together by a running suture. This double support gives strong protection from extrusion.

DR. EDWARD JACKSON, Denver: It seems to me that Dr. Burch's method brings important additional evidence of the function of the cornea in preserving the form and anatomic significance of the eyeball. The cornea, even when it has been greatly altered, becomes largely opaque and thoroughly vascular and still has a different consistency from the sclera. It has a rigidity and ability to preserve and regain its form that the sclera does not have and never can have, and this is the element that gives better motion and more permanent balance in the nutrition of the remaining eyeball than has heretofore been realized. One should keep the cornea; even if it is an altered cornea, it serves a valuable purpose.

DR. FRANK E. BURCH, St. Paul: When the series of case reports which were too lengthy to read here are reviewed or read in the *Transactions* of the society, it will be noted that a variety of methods was followed in developing the technic that I have described. I was not able to find any previous reports in the literature of anything of this kind, and the purpose of trying this new method was largely for cosmetic reasons. In 2 instances among these 26 cases, 22 of which are reported, an ulcer followed during the period of hospitalization. They were mild and responded to treatment promptly. At no time after the prosthesis was fitted has a late ulcer of the cornea developed, to my knowledge. It has been found that chemosis, or, as I call it, "tenonitis," is best controlled by an elastoplast pad and bandage at the time of operation. The patients who had pressure applied had the least chemosis, but when it does occur applications of lead water and tincture of opium rapidly control it. The best cosmetic results have been obtained by use of shell eyes that are really "tailor made" and are a good match for the fellow eye.

MEDICAL OPHTHALMOLOGY. DR. EDWARD JACKSON, Denver.

Ophthalmology was formerly known as ophthalmic surgery. The development of physiology, pathology, microbiology, neurology and methods of ophthalmic diagnosis have made medical ophthalmology more important than ophthalmic surgery. Recognition of errors of refraction and their effects on the nervous system, ophthalmoscopic evidence of ocular symptoms of many general diseases, the neuropathology of vascular and neural diseases, the exact study of visual acuity and the fields of vision and the relation of visual acuity and the visual fields to the general metabolism, as shown in endocrinology, and the influence of vitamins make the exact observation of living processes in the eye of supreme importance in many fields of internal medicine and general surgery. Ophthalmology has become the best known and important approach to preventive medicine.

ACCURACY FACTORS IN SELECTIVE THERMOTHERAPY. DR. W. E. SHAHAN, St. Louis.

This paper will be published in full, with discussion, in a later issue of the ARCHIVES.

COURSE OF CERTAIN CASES OF ATROPHY OF THE OPTIC NERVE WITH CUPPING AND LOW TENSION. DR. ARNOLD KNAPP, New York.

This paper will be published in full, with discussion, in a later issue of the ARCHIVES.

ROLE OF ASCORBIC ACID IN THE MECHANISM OF SECRETION OF THE INTRAOCULAR FLUID. DR. JONAS S. FRIEDENWALD, DR. WILHELM BUSCHKE (by invitation) and HARRY O. MICHEL, PH.D., Baltimore.

This paper will be published in full, with discussion, in a later issue of the ARCHIVES.

HYPERPHORIA TESTS BASED ON A NEW PRINCIPLE. DR. F. H. VERHOEFF, Boston.

This paper will be published in full, with discussion, in a later issue of the ARCHIVES.

CONGENITAL ANOMALIES OF THE EYE WITH CLINICAL IMPLICATIONS: REPORT OF TWO RARE CASES. DR. PARK LEWIS, Buffalo.

CASE 1.—Partial cataract and opacities of the vitreous simulating blastoma of the retina were found in the eye of an infant. Microscopic examination showed unusual deficiencies and displacement of structure.

CASE 2.—Intraocular hypertension was found in the eye of a young man, associated with aniridia, anterior polar cataract, clouding of the cortex of the lens and nystagmus. By gonioscopic examination the iridocorneal angle was found to be free from obstruction. The hypertension was lowered by the use of pilocarpine.

A study of other cases of aniridia and of increased intraocular tension with unobstructed iridocorneal angle leads to the conclusion that increased intraocular tension is not always due to obstruction of the canal of Schlemm.

#### DISCUSSION

DR. PARKER HEATH, Detroit: I would make a plea for the clinical study of cases of aniridia, because they may offer some valuable information as to the pharmacologic effect of pilocarpine. This case, with absence of iris, seems rather extraordinary, and one can theoretically suggest several explanations for the reduction of tension, one being the effect of pilocarpine in what one may call the Friedenwald zone—the decrease in permeability or the reduction in fluid and lessened production of aqueous at its source and the altered aqueous in Schlemm's canal by nature of the fluid escaping. Thus ordinarily crystalloids and colloids are picked up at the iris, and without the iris the nature of the fluid which escapes from the capillary is altered. Also the presence of the lenticular changes is extraordinarily interesting, and this may suggest that the iris itself is a factor in producing these changes. Of course the lens would have to be observed early in fetal life to see whether the absence of the iris in the early stage of the embryo would make the lens change. In other words, the iris itself may be an important factor in the metabolism of the lens.

Another point which is interesting in Dr. Lewis's case is the effect on the so-called zonular barrier—whether the zonula has any effect in glaucoma. I make a plea, then, for further study of cases of aniridia as a contribution to the problem of glaucoma and also to the pharmacologic effect of miotics.

EFFECT OF ANOXEMIA ON THE DARK ADAPTATION IN THE NORMAL AND THE VITAMIN A-DEFICIENT PERSON. DR. ROBB McDONALD (by invitation) and DR. FRANCIS H. ADLER, Philadelphia.

This paper will be published in full, with discussion, in a later issue of the ARCHIVES.

THE RETINA IN CASES OF SURGICALLY TREATED PRIMARY HYPERTENSION. DR. HENRY P. WAGENER and DR. PAUL L. CUSICK, Rochester, Minn.

This paper will be published in full, with discussion, in a later issue of the ARCHIVES.

TREATMENT OF TRACHOMA WITH SULFANILAMIDE. DR. PHILLIPS THYGESON, New York.

Of 22 patients with trachoma treated with sulfanilamide at the Vanderbilt Clinic, 12 showed an arrest of the condition, 7 showed striking improvement and 3 were not influenced. Trachomatous keratitis and papillary hypertrophy of the conjunctiva responded rapidly, but follicular hypertrophy disappeared only after considerable delay. Most rapid response was obtained in cases in which there was no secondary bacterial infection. The disease in the 3 cases in which treatment had no influence was in the late cicatricial stage with gross secondary infection and xerotic changes.

#### DISCUSSION

DR. HANS BARKAN, San Francisco: May I ask whether the disagreeable reactions occurred in patients in the hospital after a larger dose and a shorter time, or whether they occurred in ambulatory patients given a smaller dose over a longer time?

DR. NORMA B. ELLES, Houston, Texas: I should like to ask Dr. Thygeson's opinion about neoprontosil (disodium 4-sulfamido-phenyl-2'-azo-7'-acetylamino-1'-hydroxynaphthalene-3', 6'-disulfonate) in solution dropped into the eye when a 1 per cent solution is used.

DR. JOHN GREEN, St. Louis: I am inclined to agree with Dr. Thygeson that in some patients who might have an intolerance to the drug a small dose over a long period may be efficacious. I have in mind one patient who had lost an eye from trachoma. He had a perforating ulcer of the cornea for which the eye had to be enucleated, and he had recurrent pannus in the other eye with ulceration. He showed an extraordinary susceptibility to the drug, and the dose had to be reduced to 5 grains (0.324 Gm.) three times a day; that amount over a period of two months effected a great improvement in the condition.

DR. PHILLIPS THYGESON, New York: In reply to Dr. Barkan, the two severe toxic reactions did occur in hospitalized patients given large doses.

I have started the use of neoprontosil, and it seems that in the few cases in which it has been used it was equally efficacious when slightly larger doses are employed. I have one case in which sulfapyridine apparently showed beneficial results.

In reply to Dr. Elles, I have had no experience with solution of prontosil instilled in the eye.



## FRENCH OPHTHALMOLOGICAL SOCIETY

*Fifty-Second Congress, Paris, May 8-11, 1939*

First Session, May 8

SUNLIGHT AND VERNAL CONJUNCTIVITIS. DR. PIERRE FROGÉ, Le Mans, and DR. JEAN CHINIARA, Damas, Syria.

An 18 year old youth suffered for three years from vernal conjunctivitis which occurred each summer. He also presented vitiligo confined to the exposed regions on the face, neck and hands. The authors insist on the fact that light is one of the possible causes of vernal conjunctivitis, such a causation being supported by clinical and experimental data. Hypothetically, the hypophysis could be the intermediary between light and the ocular lesion.

OCULAR ALLERGY: NEW OBSERVATIONS. DR. JEAN SÉDAN, Marseille, and DR. ANDRÉ KOUTSEFF, Toulon.

The 3 cases presented here prove the extreme diversity of the clinical forms of ocular allergic manifestations.

CASE 1.—A 56 year old man had several attacks of unilateral acute iritis in association with a chronic periurethral infection. An iridic allergic reaction occurred ten hours after each urethral dilation with a Béniqué sound.

CASE 2.—A 37 year old woman was found to be intolerant to atropine during catamenia and later during the course of a normal pregnancy, a typical allergic conjunctival and cutaneous reaction occurring. There was a complete cessation of the phenomena after the menstrual period and after the termination of the pregnancy.

CASE 3.—A 29 year old woman who was suffering with iritis and who had had a perfect tolerance for atropine began to present an allergic conjunctival reaction to the drug after total hysterectomy. Therapy with ovarian extract attenuated the allergic phenomena markedly.

The first case presents a typical example of infectious allergy (focal infection). The other two show the relation between allergy and the secretion of the endocrine glands.

EXPERIMENTAL RESEARCHES ON THE OCULAR REACTIONS OF RABBITS IN ANAPHYLAXIS. DR. RENÉ NECTOUX, Paris.

The author defines the essential signs which characterize the anaphylactic syndrome and which are common to all species, including the rabbit. He shows that the reactions in this animal following the provoking injection in the conjunctiva reproduce the complete syndrome, characterized by the intensity of the phenomena, their early appearance and specificity and the possibility of the production of an anaphylactic state. It is the same in the vitreous, but here the phenomena are accompanied by an increase in the intraocular tension which is never found in the control animals and the determination of which permits appreciation of the hypersensitivity of the animal and of the value of desensitization. The author emphasizes the possible importance of a correlation between these experimental facts and certain clinical data.

CHOLESTEROL INFILTRATION IN THE CORNEAL LAMINAS. DR. L. GENET and DR. JOSEPH F. MARTIN, Lyon.

Cholesterol is not solely a waste product in the metabolism of fats. Some recent researches have shown the relation of cholesterol to the hormones, the vitamins and certain cancerigenic substances. Cholesterol exists in all tissues, especially in the blood, and its determination should be done more frequently than it is.

The authors present some observations on this question, most of which concern eyes involved with old and serious lesions. (Slides of microscopic sections of an eye showing cholesterol infiltration in the cornea and in the underlying tissues were shown.) Cholesterol comes from food materials and is found also in the organism in the adrenals and the corpora lutea. Its involutional cycle is hard to describe precisely, because cholesterol is insoluble in water. It seems to be derived from oleic acid. From the therapeutic point of view, the corneal infiltrations are neither painful nor dangerous. As a rule, the cholesterol remains unmodified, but it can, in certain cases, be completely eliminated. The main forms of treatment consist of ocular baths in lithium oxide, the use of iodides and the observation of colloidal phosphatides in the form of "sclerolysin."

TREATMENT OF TRACHOMA WITH BENZENE AND BENZENE COMPOUNDS: EXPERIMENTAL STUDY. DR. C. DEJEAN and DR. P. ARTIÈRES, Montpellier.

Since benzene has a destructive action on lymphoid structures, it seemed logical to the authors to try it on the granulations of trachoma. Unfortunately it is caustic and noxious for the tissues. Benzene, pure or in a 50 per cent dilution, instilled on the rabbit conjunctiva provokes corneal lesions. It is rather well tolerated in dilutions of 20 per cent or less.

Benzene injected subconjunctivally is still more irritating, since even in a 20 per cent dilution it attacks the cornea. To make it harmless, dilution to 5 per cent is necessary, and even then accidents are possible. Only the 1 per cent dilution seems to be completely safe, but the authors have not dared to use it for human trachoma. To insure greater safety, they have resorted to the use of the organic benzene compounds. Synthol (a synthetic preparation proposed as a substitute for absolute alcohol), well tolerated by animals and man, is still being studied. Septazine (a derivative of sulfanilamide containing two benzene radicals) in tablet form has given only deceptive results. On the contrary, its soluble derivative, soluseptazine (disodium *p*-[ $\gamma$ -phenylpropylamino]-benzene-sulfonamide- $\alpha$ - $\gamma$ -disulfonate), in subconjunctival injections seems to be an excellent antigranular agent and has given a series of incomparable results in the treatment of some resistant trachomatous infections of long standing.

EPITHELIOMAS OF THE LIMBUS. DR. PAULIN and P. DUPUY-DUTEMPS, Paris.

In publishing the good results obtained with radium irradiation of two epibulbar epitheliomas, the authors offer a few restrictions because of the possible risks to the treated eye.

Since the only surgical procedure in such cases is enucleation, radium therapy seems to be the treatment of choice. The advantages of radium over other physical agents are obvious from the technical point of view as well as from its elective action on these tumors.

OCULAR PEMPHIGUS. DR. W. J. KAPUSZINSKI JR., Poznan, Poland.

Two cases of ocular pemphigus are reported in which the author was fortunate enough to observe the disease from its onset.

CASE 1.—A 21 year old girl, who had slight signs of hyperthyroidism and some menstrual irregularity, presented a mild stationary form of pemphigus which was characterized by marked shrinking of the conjunctival membranes and slight degeneration of the cornea. The objective ocular condition was related to the intensity and regularity of the menstruation.

CASE 2.—A boy 10 years old had an advanced symblepharon due to pemphigus and also corneal lesions characterized by subepithelial degeneration and slight vascularization which interfered considerably with the visual acuity. He exhibited endocrine disturbances, mostly hypophysial, and eosinophilia. Examination of tarsal sections revealed a thickening involving many scores of epithelial layers, a mucinous degeneration of the epithelial cells and a marked secondary chronic inflammation of the conjunctiva.

These 2 cases confirm the 4 described by the author in the *Annals d'oculistique* in 1937 (vol. 174, p. 451) and permit him to make the following conclusions:

1. Ocular pemphigus is a disease characterized by a fundamental degeneration of the conjunctiva, especially of the epithelium.
2. The corneal pathologic process involves only the superficial layers, which are of ectodermal origin.
3. The pathologic process in the cornea can be parallel to that in the conjunctiva.
4. The state of chronic inflammation is nothing but a secondary lesion.
5. One cannot exclude a relation between ocular pemphigus and endocrine metabolism.

BIOMICROSCOPY AND DIAPHANOSCOPY. DR. PIERRE LEMOINE, Nevers, and DR. GEORGES VALOIS, Moulins.

Diaphanoscopy is particularly useful for examination of the region which Trantos has called *proophthalmoscopique* and which comprises the iridocorneal angle, the ciliary body and the preequatorial part of the retina.

The exploration of this part of the eyeball is easily made by applying with moderate pressure on the region to be examined the light-bearing end of the ophthalmoscope. The authors exhibited a diaphanoscope which they have devised for their biomicroscope. The function of these two instruments makes microdiaphanoscopy examinations much easier.

THE DECREASE IN THE INCIDENCE OF A FEW OCULAR DISEASES. DR. HENRI VILLARD, Montpellier.

The author recounts the decrease and almost complete disappearance of a few ocular diseases in the last decades: ophthalmia neonatorum, gonorrheal ophthalmia in the adult, lacrimal fistula, gumma of the iris, syphilitic choroiditis, atrophy of the optic nerve in tabes, strumous ophthalmia gravis and palpebral pityriasis. The cause of such changes in the status of the first mentioned disease is the use of Credé's method of prophylaxis; of the second, the advice given to patients with gonorrhea; of the third, the surgical treatment of dacryocystitis which prevents the infection from reaching the final stage of fistulization, and of the syphilitic manifestations in the iris, the choroid and the optic nerve, the early and intensive treatment of that disease with injections of mercuric, arsenical or bismuth preparations. Lastly, the decrease in the incidence of strumous ophthalmia and palpebral pityriasis is due to the improvement of general and dietary hygiene of children and body cleanliness.

Second Session, May 9

OCCUPATIONAL ACCIDENTS AND PROFESSIONAL DISEASES. DR. J. VIDAL and DR. H. VIALLEFONT, Montpellier.

The authors review the principal characteristics which differentiate occupational accident from professional disease. They emphasize the difficulty that one can experience in classifying a given case in one or the other of these groups, such classification being of consequence in the question of compensation.

In dubious cases their opinion is that according to the jurisprudence one can classify among occupational accidents, all of which entitle the patient to compensation, those which, due to an unforeseen external event, localized in time, have brought about the pathologic condition.

THE EYE AND PROFESSIONAL DISEASES. DR. C. COUTELA, Paris.

Being a superficial organ, the eye is directly exposed to dusts, vapors and gases of mineral, vegetable or animal origin, whether they are inert (acting mechanically) or active (acting through their caustic or septic characters). Lesions can be produced on the eyelids, the conjunctiva, the cornea and the lacrimal ducts. Diverse dermatoses, frequently occupational and often localized to the eyelids, deserve special mention. They have a peculiar chemical aspect due to the thinness of the skin and the extreme elasticity of the subcutaneous tissues. Some of these dermatoses are purely of toxic origin. Others, on the contrary, develop only if there is an individual predisposition. Vidal and his associates have brought to light a special aspect of this question.

The mineral elements may be of a well determined nature, such as stone, marble or emory dust (Dr. Coutela reports strange observations in regard to these), sands (used in the cleaning of walls or metals), silica, sodium hydroxide, lime, cement, alabaster, asbestos, coal, silver, copper, lead (used in vinegar factories), mercury (used for conditioning of fur skins), arsenic and sulfur (employed by vine sprayers). Any vapor can cause an ocular disturbance, even that of chromic acid, which gives rise to black staining of the cornea. Some other elements are of a more complex nature. Such are the sulphydric and ammoniacal vapors, which affect scavengers and cause keratitis in workers in artificial silk.

the chemical fertilizers, war gases and coal derivatives, which cause the dermatoses of coal miners. The lesions due to tar and resin can progress from common irritation to folliculosis and even to a malignant condition. It is admitted that external irritation produces a precancerous state, which in some predisposed persons gives rise to a cancerous metaplasia. Added to this list of irritants are aniline and its derivatives (so frequently used in the making of dyes), the solvents and cellulose varnishes (so widely used now), methyl alcohol, powders and explosives (nitronaphthalin).

The vegetable elements are numerous: indigenous and exotic woods, flowers, hops, flours, vegetables, mushrooms, tobacco and pharmaceutic products, among which are podophyllin, which causes corneal and iridic lesions, turpentine, mustard, vanilla, lac and amber. Manchineel wood can provoke in persons who work with it ocular disturbance with deafness.

Among the elements of animal origin are to be noted fur skins (removal of coarse hairs from furs sometimes giving rise to visual disturbances, mostly through the medium of the nasal and postnasal cavities), hairs, wools, catapillars and mother-of-pearl.

Protection of workers against fumes, gas and vapors is obtained with masks and eyeglasses. There is also a psychologic factor, education of workmen being of main importance.

An organ physiologically devised for transparency, the eye is penetrated by rays. Workers can be harmed either by visible or by invisible rays (ultraviolet, infra-red and roentgen rays and radiations from radioactive substances). Sunlight can cause severe "radiolucitis"; some authors claim that it can provoke cataracts. Invisible radiations provoke ocular disturbances in workers in oxygen welding, steel cutting, metal grinding and glass and film production, and keratoconjunctivitis, dimness of vision due to electric light and cataracts have been reported.

Professional handlers of radium or roentgen rays have been found to have radiodermatitis and conjunctivitis (occasionally resulting in carcinoma) in addition to some lenticular lesions.

Worthy of note are the ocular alterations encountered in association with the leukemia of roentgenologists and the osteogenic sarcoma of a few workers in radioactive substances.

Being highly vascularized and enervated, the eye is exposed to intoxications from lead, sulfocarbonate, hydrocarbon, benzene, trichloroethylene (causing involvement of the trigeminal nerve) and also to infections, such as acute and subacute conjunctivitis, trachomatous conjunctivitis (in workmen and in physicians), anthrax, tetanus, vaccinia, glanders, syphilis (in workers and in physicians, especially in rhinolaryngologists), tularemia, icterohemorrhagic spirochetosis, brucellosis, sporotrichosis, actinomycosis and ankylostomiasis.

Finally, the delicacy of the structure of the eye and its unceasing activity are responsible for the fragility and sensitiveness to fatigue of the oculomotor apparatus, the accommodation and the sensorial elements of the visual organ. An example of this is found in the nystagmus of coal miners and in the ocular disturbances due to close work (printers, precision mechanics, etc.). The report ends with the medicolegal dispositions concerning the different professional diseases calling for indemnity or repair and with the general principles on professional orientation and selection.

## Third Session, May 10

ACTION OF ASCORBIC ACID ON SENILE CATARACT. DR. PAUL JEANDELIZE, Nancy; DR. PAUL DROUET, Nancy, and DR. LORENZO BARDELLI, Florence, Italy.

The authors report the results obtained in 40 cases of senile cataract with the use of ascorbic acid. They have obtained in general visual improvement, sometimes even when the cataracts were in a late phase. The improvement has often been shown to be quite notable. Typical of this form of treatment is its rapid effectiveness. There is still much to be learned on the subject. The authors plan to publish new precise facts in the near future.

TECHNIC OF TOTAL CATARACT EXTRACTION. R. DE SAINT-MARTIN, Toulouse.

With the recognition of the superiority and innocuous character of total cataract extraction, every one must try to obtain the highest possible percentage of optimal extractions, that is to say, without rupture of the capsule, without operative accidents and with the remarkably simple postoperative course which is typical of this type of intervention. The only way to accomplish this is to be guided by the two standard technics, leaving aside the innovations not yet confirmed by experience. Thus, one should follow the Stanculeanu-Knapp-Török-Elschnig method for the forceps operation and the Barraquer method for the suction extraction. If the use of the forceps is actually more widespread, it is probably because of the undeserved discredit cast on the suction method on the alleged grounds of the difficulty of its use, the brutality of its action and the danger of serious accidents from it. Properly handled, the suction apparatus extracts the lens more gently than the forceps does. It renders possible the extraction within the capsule of cataracts which are not suitable for the forceps extraction (intumescent cataracts or hard ones with a large nucleus). The operative success depends on the correct execution of every operative phase and the observance of the "safety procedures," on a dosage of the vacuum degree in proportion with the supposed resistance of the capsule and on the use of a progressive vacuum-generating apparatus which will permit the adhesion of the capsule to the suction cup with a minimal risk of rupture.

The greatest number of successful interventions can be obtained by combining both technics. The suction technic is used first, a slight amount of suction being employed. If it is insufficient, the cataract slides, at least it has in most cases in which this method was used, without rupture of the anterior capsule, and the zonular fibers are sufficiently torn or dislocated to permit forceps extraction without difficulty.

The author has thus obtained a percentage of integral extractions of 95.99.

INTRACAPSULAR EXTRACTION IN PIGMENTARY RETINITIS AND FISTULOUS GLAUCOMA. DR. GABRIEL P. SOURDILLE, Nantes.

Some complicated cataracts are particularly suitable for total intracapsular extraction, which appears to be the author's operation of choice. He discusses only the posterior cataracts of pigmentary retinitis and the cataracts appearing in the evolution of fistulous glaucoma. The former, maturing slowly and incompletely, are considered inoperable while they

obstruct only the central visual field. The extracapsular operations for cataracts after fistulization of glaucoma usually results in the widening of the fistula, due to septic or aseptic irritation which almost necessarily follows the resorption of materials set free by cystotomy. The author stresses a few particular points of surgical technic and recommends in some cases of cataracts observed in nonfistulous glaucomatous eyes a scleral resection of the Lagrange type together with extraction of the lens.

FIRST TOTAL CATARACT EXTRACTION WITH ARRUGA'S SUCTION APPARATUS. DR. JACQUES BINET, Bourges.

Arruga's suction apparatus permits a greater number of total extractions than does the forceps. The visual results for the first 20 persons subjected to this type of extraction follow: 10/10, 8 patients; 8/10, 3 patients; 7/10, 5 patients; 3/10, 1 patient, and less than 1/10, 3 patients. Thus 80 per cent of the patients had vision of more than 7/10. Post-operatively prolapse of the iris occurred in 1 case on the fifth day, and in 2 cases there was late detachment of the retina. The most extensive statistics estimate at 1 per cent the risk of retinal detachment.

INTRACAPSULAR EXTRACTION OF CATARACTS WITH DUVIGNEAUD-ROCHON'S SUCTION APPARATUS. DR. JULES FRANÇOIS, Charleroi, Belgium.

After describing his personal technic of intracapsular extraction of cataracts with Duvigneaud-Rochon's suction apparatus, the author gives his results: Of 114 attempts of total extraction, 90 were completely successful, 15 were partially successful and 9 were failures. The complications which occurred follow: outflow of the vitreous, 8.8 per cent; prolapse of the iris, 5.5 per cent; hyphemia, 10 per cent; cloudiness of the vitreous, 7.7 per cent; iridocyclitis, 6.6 per cent; infection, 1.1 per cent, and glaucoma, 2.2 per cent.

TRANSFIXION OF THE IRIS IN GLAUCOMA SECONDARY TO PUPILLARY SECLUSION (TOMATO IRIS). DR. P. LAVAT, Paris.

That excellent operation described in 1896 by Fuchs and brought back into light by Drs. Duverger and Velter is not as well known as it deserves to be.

Because of its simple technic, transfixion of the iris can be considered as a minor emergency operation, use of which avoids iridectomy, which in the case of glaucoma secondary to pupillary seclusion becomes a delicate and serious operation.

Six personal cases in which this technic was successful are reported by the author to prove the beneficial effect of the operation in glaucoma of this type.

CONGENITAL MALFORMATION OF THE FLAT CILIARY RETINA: CONSIDERATIONS ON VITREOZONULAR ONTOGENESIS. DR. M. TEULIÈRES, DR. J. BEAUVIEUX and DR. E. BESSIÈRES, Bordeaux.

The authors report the case of a girl aged 9 years in which the diagnosis of tumor of the ciliary body had been made. A long period

of observation seemed to lead to a diagnosis of a congenital lesion rather than of a true tumor. Actually enucleation showed that they were dealing with developmental disturbance of the distal layer of the secondary optic vesicle. The lesions consisted of an amorphous mass in the flat ciliary retina; the mass presented all the histologic characters of collagenous substance and rested on a hyperplastic retina. From this amorphous and structureless mass sprang some zonular and vitreous fibers which extended as far as the posterior surface of the lens. The visual retina was hollowed with many cystic cavities, and collagenous masses were observed not only around the retinal and papillary vessels but in front of the papilla.

Such lesions give rise to an interesting interpretation in relation to the ontogenesis of the vitreous and the zonula. According to the authors, these lesions are apparently the result of hyperplasia of the orbiculus ciliaris due to some unknown inflammatory factor. That hyperplasia has given birth, through the intermediary of the neuroglia fibers, to a mass in the vitreous, which was abnormally solidified and did not absorb, and through the intermediary of the neuroepithelium, to a zonula which was disturbed developmentally and enclosed in that amorphous mass. The persistence of a few collagenous clumps in the visual retina and the disk seems to demonstrate equally the importance of the role played in the genesis of the vitreous by the retina proper and by the hyaloid neuroglia. This congenital malformation of extreme rarity would support the ectodermic theory of ontogenesis for the vitreous and the zonula.

PROGNOSIS OF GUNSHOT WOUNDS OF THE EYEBALL. DR. P. VEIL,  
DR. L. GUILLAUMAT and DR. I. T. TOK, Paris.

The authors review the recent works on the prognosis of gunshot wounds of the eye and then report 22 cases observed by them at the Hôtel Dieu Hospital in the course of the past ten years. Most of the projectiles were localized in the vitreous. Such an injury causes immediately a marked decrease of vision due to hemorrhage in the vitreous and anterior chamber, with occasional hernia of the iris. Later, a fibrous organization of the vitreous occurs, leading to detachment of the retina or atrophy of the eyeball.

In 10 cases enucleation was necessary due to iridocyclitis appearing usually within the first three months after the accident. The seriousness of such wounds depends more on the immediate contusions and on the number and the force of impact of the projectiles than on the septic nature, which is rare, and the chemical toxicity of lead. Vision was almost abolished in 19 of 22 cases.

FLAT SARCOMA OF THE CHOROID. DR. F. TERRIEN and DR. J. BLUM,  
Paris.

The interest in flat sarcoma of the choroid lies in its rarity and in the characteristics by which it is differentiated from the circumscribed form of sarcoma. These characteristics consist of rapid development after an undetermined latent phase, the polymorphism of the constituent cells, the frequent extensive growth of the tumor on the surface, the early hypertension, which is sometimes suggestive of an attack of glaucoma, and the frequent coexistence of inflammatory phenomena, which usually precedes the appearance of symptoms of tumor.



## Fourth Session, May 11

OCULAR TEMPERATURE. DR. PAUL BAILLIART and DR. RENÉ BIDEAU, Paris.

The authors emphasize the importance of thermal determination of the eye from both physiologic and clinical points of view.

They describe the original apparatus devised and used by them: Mercury thermometers cannot be utilized on account of their great caloric inertia, so they have applied thermoelectric couples. With those specially shaped couples they have been able to avoid cocainization, which is a source of error in the most usual determination, that of the conjunctival temperature. This temperature is extremely variable and is modified even by the presence of the measuring apparatus. It seems to average 36 C. in man. The thermic reactions provoked by the usual collyria, ethylmorphine hydrochloride, epinephrine hydrochloride and cocaine hydrochloride, on the conjunctiva have also been studied. Pathologically, the inflammatory conditions (iritis and traumas) bring a rise in temperature of 1 to 1.5 C.

However, those are only the results of preliminary research, and now, having the adequate instrumentation, the authors plan to study the thermic and, consequently, the vascular reactions provoked by focal disturbances. This line of investigation appears promising to them.

CHARACTERISTICS OF OCULAR BURNS WITH CHROMIC ACID. DR. F. POLLET-DELILLE, Tourcoing.

As yet lesions following entry into the eye of a large quantity of a 90 per cent solution of chromic acid have not been described. The corneal lesions thus produced are characterized macroscopically by (1) a short period (three days) of acute irritation of the epithelium accompanied with intense watering of the eye and photophobia and (2) a long period (several months) of corneal trophic disturbances, loss of the epithelium, anesthesia and alternating phases of epithelization and loss of epithelium and microscopically by (1) primary edema of the deeper layers of the cornea, evidence of the lesions of the nerve endings fixed by chromic acid, and (2) infiltration and cicatricial organization of the superficial layers a few weeks after trauma. The prognosis appears good during the first days after the accident. One should not be mistaken. The wound follows the evolutionary type of neurotrophic keratitis, and prognosis should be extremely reserved.

Treatment consists mostly, after disinfection and as soon as there is no danger of symblepharon, in preventing secondary trophic disturbances by early tarsorrhaphy.

DIVERGENT STRABISMUS. DR. RENÉ ONFRAY, Paris

In regard to the classification of divergent strabismus, the author emphasizes once more the necessity of determining precisely in each case (a) the peripheral sensorial condition (refraction, visual acuity and organic condition of the eyes), (b) the oculomotor condition (visual field for close and distant convergence) and (c) the central coordinations (whether binocular vision is educated or not, simultaneous vision, image projection and retinal concordance). Precise knowledge of all these factors is necessary to distinguish the cases in which one can expect to maintain binocular vision from those in which one can only aim at esthetic correction.

Strabismus associated with low or medium myopia should be treated with optic correction and orthoptic exercise, but when the convergence is only 2 degrees symmetric advancement of both medial rectus muscles should be done. Marked myopia of 9 or more diopters needs only optic correction, as divergence is nothing but a defense mechanism against the fatigue of too close binocular vision.

In the cases in which convergent strabismus has become divergent unilateral operation is employed (medial advancement of the medial rectus muscle with tenotomy of the lateral rectus muscle). For secondary postoperative strabismus and also for certain cases of strabismus associated with unilateral amblyopia of organic origin, the same surgical procedures are indicated. True congenital alternating divergent strabismus without refractive errors in persons about 12 years of age requires a symmetric advancement of the medial rectus muscles without tenotomy of the lateral rectus muscles. Binocular vision is rarely obtained, and neutralization of one of the images must often be respected in order to avoid annoying diplopia.

The author concludes by recalling that the pathologic process in these cases is completely unknown and that it would be interesting to examine elderly persons from public institutions for alternating divergent strabismus without refractive errors and later to examine serial sections of the midbrain for eventual lesions which would throw light not only on the problems of strabismus but on the anatomic structure of the oculomotor association pathways.

STEREOSCOPIC VISION WITHOUT THE STEREOSCOPE: FUSION AND RELIEF. DR. M. MARQUEZ, Madrid, Spain.

The author throws light on the subject of stereoscopic vision by insisting that various errors which find their origin in stereoscopic vision are simple physical phenomena which can be explained as simply on the physical basis of the stereoscope. The latter is not indispensable, however, as already noted by Brewster, for observing these abnormal varieties of binocular vision in which there is diplopia which brings in fusion the two medial pictures of the four produced by the doubling of the stereogram. Parinaud's theory, being physiologic, is then exact. The septum of the stereoscope suppresses the two lateral images, and without relief. There is also a psychic phase in which after rapid successive convergences the sensation of relief suddenly appears. That sensation is purely an illusion. Lastly, fusion and relief are in close relation, the former being the necessary phase prior to the production of the latter.

METASTATIC ORBITAL TUMOR, SECONDARY TO A RENAL EPITHELIOMA WITH LATE MANIFESTATION. DR. MARCEL KALT and DR. HENRI TILLÉ, Paris.

A man presented diplopia with slowly progressive exophthalmos. Biopsy of a specimen of the tumor exposed at the inferoexternal angle of the orbit showed the growth to be a "clear-celled epithelioma of the lacrimal gland of pseudoendocrine aspect," related by analogy to mixed tumors of the salivary gland of relatively benign prognosis. As the visual acuity was good and the patient was free from pain, simple

orbitotomy was performed and almost all of the tumor removed. Exophthalmos regressed notably, but after four and one-half months a recurrence appeared.

On the day before that appointed for orbital reoperation, the patient had a hematuria, which drew attention to the kidneys. Nephrectomy was done on the left kidney. Pathologic examination showed a renal epithelioma with eosinophils degenerated for the most part into clear cells, loaded with fatty and lipid inclusions. The growth was diagnosed this time as a metastatic orbital carcinoma of renal and not of adrenal origin, a condition which is rare. A second biopsy confirmed the histologic identity of the two tumors and contraindicated further operation.

The pressure of the tumor on the posterior pole had provoked an acquired hyperopia (of variable degree following the evolution), some interpapillomacular retinal folds and lastly papilledema, which had remained partial and was followed by stasis (blindness came then suddenly).

The authors insist on the absolute latency over an eighteen month period of the primary renal carcinoma. In their case the general condition and the renal function remained normal to the time of the hematuria. They recommend systematic physical examination of all the organs in case of an apparently primary orbital tumor.

#### SENILE PSEUDOTUMOROUS OCULAR DEGENERATION. DR. A. MAGITOT and DR. M. LENOIR, Paris.

The authors report a case of senile pseudotumorous ocular degeneration and present an anatomic study illustrated with numerous slides in order to demonstrate the genesis of the disease. According to them, the condition consists of a macular detachment due to a pathologic secretory activity of the pigmented epithelium. The epithelial cells show many transformations: proliferation, changes in shape, hyaline degeneration and mobilization. The tumor is made up of a conglomeration of these cells which have penetrated into a folded retina and progressed to cystic degeneration. The cause of all these modifications should be found to be a deficiency of nutritive exchanges and especially an insufficient nutritional supply from the capillaries of the choroid.

#### PSEUDOTUMOR OF THE IRIS (TUBERCULOSIS). DR. A. MAGITOT and DR. P. MORAX, Paris.

A 19 year youth had detachment of the retina and tumefaction of the iris without pain and with a few areas of iridocyclitis. The eye was enucleated for fear that the growth was malignant. The patient's health was improved for two months, when suddenly there was an aggravation of the condition and he died of generalized miliary tuberculosis. At the time of enucleation, nothing could point to such a death. The anatomic examination of the enucleated eye revealed that the tumor was, in fact, a cystic degeneration with false membranes. The eye was filled with tuberculous nodules, with, in some places, caseous degeneration.

#### OCULAR TUBERCULOSIS. DR. WITOLD KAPUSCINSKI, Poznan, Poland.

There is much discrepancy in the opinions of authors concerning the role of tuberculosis in ocular disease. These differences originate

in the variable manifestations of tuberculosis in the organism as well as in the impossibility of supplying evidence of its presence; that is to say, of detecting Koch's bacillus in intraocular foci. The other methods of investigation, tuberculin tests notably, are of only relative value. From the clinical standpoint, it is only exceptional for ocular tuberculosis to appear absolutely typical.

The author describes a case of iridocyclitis with "tuberculous" nodules on the iris of each eye. However, all the clinical tests for tuberculosis, including injections of tuberculin up to 25 mg., as well as inoculation of the nodules in a guinea pig and a rabbit, were completely negative. Microscopic sections of the eyeball revealed nontypical cellular infiltrations in the ciliary body and a nodule formed by epithelioid cells without necrosis or giant cells in the choroid. There were no Koch bacilli.

After reviewing the literature on the subject the author concludes that the problem of ocular tuberculosis deserves a more critical consideration than has generally been given it.

#### TUBERCULOUS ORIGIN OF CERTAIN RECURRING HEMORRHAGES. DR. C. DEJEAN and DR. J. FERRIÉ, Montpellier.

The authors report 3 cases of recurring retinal hemorrhages, 2 in patients with latent bacillary infection and the other in a 22 year old woman treated for active pulmonary tuberculosis and in whom the hemorrhages in the vitreous were coincident with aggravation of the pulmonary lesions, frequently even with hemoptyses.

As to this last case, in which the fundus revealed no previous vascular alteration, the authors think that the cause of the hemorrhages resided not in anatomic vascular alterations but rather in a physiologic disturbance of the circulation. Tuberculosis, which they consider as one of the causes of the condition, would upset the neurovegetative system and could thus give rise in the eye as well as in the lung to an intense congestion, producing hemorrhage by vasodilatation. The phenomena observed in a tuberculous woman with hemoptyses in whom the pulmonary and retinal hemorrhages used to take place due to sudden vagosympathetic disturbances supports the hypothesis, which explains equally well that causes other than tuberculosis, endocrine disturbances notably, could have the same effect.

#### CRANIAL TRAUMA FOLLOWED BY THE FOSTER-KENNEDY SYNDROME. DR. R. HERMANS, Brussels, Belgium, and DR. G. DE BROEN.

An 18 year old youth was run over by an automobile. After a few hours he became comatose. A fracture of the nasal bones was found. Roentgenograms and clinical examinations revealed no other lesion. Eight days later the boy appeared cured, but a Foster-Kennedy syndrome (primary atrophy of the right optic nerve, papilledema on the left) progressively developed. Six months after the accident he died of hyperacute meningitis secondary to "flu." Autopsy revealed that the meningeal infection took place from a nonconsolidated fracture of the right lateral part of the cribriform plate of the ethmoid sinus, resulting in optochiasmic arachnoiditis.

## Book Reviews

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**Clio Medica. A Series of Primers on the History of Medicine.** Editor, E. B. Krumbhaar, M.D. **Chap. XXI. Ophthalmology.** By Burton Chance, M.D. Price, \$2. Pp. 257, with 11 illustrations. New York: Paul B. Hoeber, Inc., 1939.

This interestingly written little volume traces the main outlines of the history of the diseases of the eye and their treatment as a sort of digest of more voluminous works. From the Code of Hammurabi to the present state of the art and science of ophthalmology one learns of ophthalmology and ophthalmologists throughout the centuries. There are chapters on ophthalmic hospitals and teachers, societies and journals, the prevention of blindness, the care and education of the blind and on works on the pathology of the eye. The illustrations include de Voge's "Apotheosis of Daviel" and portraits of a number of famous ophthalmologists.

# Directory of Ophthalmologic Societies \*

## INTERNATIONAL

### INTERNATIONAL ASSOCIATION FOR PREVENTION OF BLINDNESS

President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6<sup>e</sup>, France.  
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.  
All correspondence should be addressed to the Secretariat, 66 Boulevard Saint-Michel, Paris, 6<sup>e</sup>, France.

### INTERNATIONAL OPHTHALMOLOGIC CONGRESS

President: Prof. Nordenson, Serafimerlasarettet, Stockholm, Sweden.  
Secretary: Dr. Ehlers, Jerbanenegade 41, Copenhagen, Denmark.

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## FOREIGN

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Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.  
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

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### HUNGARIAN OPHTHALMOLOGICAL SOCIETY

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Assistant Secretary: Dr. Stephen de Grosz, University Eye Hospital, Maria ucca 39, Budapest.  
All correspondence should be addressed to the Assistant Secretary.

### MIDLAND OPHTHALMOLOGICAL SOCIETY

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Secretary: T. Harrison Butler, 61 Newhall St., Birmingham 3, England.  
Place: Birmingham and Midland Eye Hospital.

### NORTH OF ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. A. MacRae, 6 Jesmond Rd., Newcastle-upon-Tyne, England.  
Secretary: Dr. Percival J. Hay, 350 Glossop Rd., Sheffield 10, England.  
Place: Manchester, Bradford, Leeds, Newcastle-upon-Tyne, Liverpool and Sheffield, in rotation. Time: October to April.

### OPHTHALMOLOGICAL SOCIETY OF AUSTRALIA

President: Dr. A. James Flynn, 135 Macquarie St., Sydney.  
Secretary: Dr. D. Williams, 193 Macquarie St., Sydney.  
Place: Perth, Western Australia. Time: Sept. 2 and 7, 1940.

### OPHTHALMOLOGICAL SOCIETY OF EGYPT

President: Prof. Dr. Mohammed Mahfouz Bey, Government Hospital, Alexandria.  
Secretary: Dr. Mohammed Khalil, 4 Baehler St., Cairo.  
All correspondence should be addressed to the Secretary, Dr. Mohammed Khalil.

\* Secretaries of societies are requested to furnish the information necessary to make this list complete and keep it up to date.

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President: Mr. T. Harrison Butler, 61 Newhall St., Birmingham 3, England.  
 Secretary: Mr. L. H. Savin, 7 Queen St., London, W. 1, England.

## OPHTHALMOLOGY SOCIETY OF BOMBAY

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 Secretary: Dr. H. D. Dastur, Dadar, Bombay 14, India.  
 Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

## OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. Percival J. Hay, 350 Glossop Rd., Sheffield 10, England.  
 Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.  
 Time: July 4-6, 1940.

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 Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.  
 Place: Lindley'a 4, Warsaw.

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 Secretary: Prof. Dott. Epimaco Leonardi, Via del Gianicolo, 1, Rome.

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 Secretary: Dr. Sadger Max, 9 Bialik St., Tel Aviv, Palestine.

## NATIONAL

## AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.  
 Secretary: Dr. Derrick T. Vail Jr., 441 Vine St., Cincinnati.  
 Place: New York. Time: June 10-14, 1940.

## AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY, SECTION ON OPHTHALMOLOGY

President: Dr. George M. Coates, 1721 Pine St., Philadelphia.  
 Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

## AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Frederick Tooke, 1482 Mountain St., Montreal, Canada.  
 Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.  
 Place: Hot Springs, Va.

ASSOCIATION FOR RESEARCH IN OPHTHALMOLOGY, INC.

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SECTIONAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON  
EYE, EAR, NOSE AND THROAT

President: Dr. Andrew Rados, 31 Lincoln Park, Newark.  
Secretary: Dr. William F. McKim, 317 Roseville Ave., Newark.  
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

CENTRAL WISCONSIN SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

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Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.

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Secretary-Treasurer: Dr. Trygve Gundersen, 243 Charles St., Boston.  
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

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Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.

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Secretary-Treasurer: Dr. Purman Dorman, 1115 Terry Ave., Seattle.  
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except June, July and August.

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Secretary-Treasurer: Dr. J. J. Potter, 303 N. Main St., Rockford, Ill.  
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month from October to April, inclusive.

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Secretary-Treasurer: Dr. Louis D. Gomon, 308 Eddy Bldg., Saginaw, Mich.  
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July and August.

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Secretary: Dr. M. P. Spearman, 1001 First National Bank Bldg., El Paso, Texas.

Place: El Paso, Texas. Time: Nov. 9-11, 1939.

## SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. Carl Wencke, Battle Creek.

Secretary-Treasurer: Dr. A. K. Zinn, Battle Creek.

Time: Third Thursday of alternate months.

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Secretary: Dr. John C. Long, 324 Metropolitan Bldg., Denver.

Place: University Club, Denver. Time: 7:30 p. m., third Saturday of each month, October to May, inclusive.

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Place: Indianapolis. Time: First Wednesday in April.

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Time: Second Friday of each month from October to May.

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Secretary-Treasurer: Dr. Paul Bailey, 833 S. W. 11th Ave., Portland.

Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

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Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.

Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.

Place: Rhode Island Medical Society Library, Providence. Time: 8:30 p. m.,  
second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. S. B. Fishburne, 1430 Marion St., Columbia.

Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. J. B. Stanford, 899 Madison Ave., Memphis.

Secretary-Treasurer: Dr. W. D. Stinson, 124 Physicians and Surgeons Bldg.,  
Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. A. N. Champion, 705 E. Houston St., San Antonio.

Secretary: Dr. Dan Brannin, 1719 Pacific Ave., Dallas.

Place: Houston. Time: December 1939.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.

Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.

Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Charles T. St. Clair, 418 Bland St., Bluefield, W. Va.

Secretary-Treasurer: Dr. M. H. Williams, 30½ Franklin Rd. S. W., Roanoke.

WEST VIRGINIA STATE MEDICAL ASSOCIATION. EYE, EAR, NOSE  
AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.

Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

## LOCAL

## AKRON ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. E. Brown, Second National Bldg., Akron, Ohio.  
Secretary-Treasurer: Dr. C. R. Anderson, 106 S. Main St., Akron, Ohio.  
Time: First Monday in January, March, May and November.

## ATLANTA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Arthur G. Fort, 478 Peachtree St. N. E., Atlanta, Ga.  
Secretary: Dr. Lester A. Brown, 478 Peachtree St. N. E., Atlanta, Ga.  
Place: Grady Hospital. Time: 6:00 p. m., second Wednesday of each month from October to May.

## BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Frank B. Walsh, Wilmer Institute, Johns Hopkins Hospital, Baltimore.  
Secretary: Dr. Fred M. Reese, 6 E. Eager St., Baltimore.  
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

## BIRMINGHAM EYE, EAR, NOSE AND THROAT CLUB

President: Each member, in alphabetical order.  
Secretary: Dr. N. E. Miles, 408 Medical Arts Bldg., Birmingham, Ala.  
Place: Tutwiler Hotel. Time: 6:30 p. m., second Tuesday of each month, September to May, inclusive.

## BROOKLYN OPHTHALMOLOGICAL SOCIETY

President: Dr. E. Clifford Place, 59 Livingston St., Brooklyn.  
Secretary-Treasurer: Dr. Frank Mallon, 1135 Park Pl., Brooklyn.  
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

## BUFFALO OPHTHALMOLOGIC CLUB

President: Dr. James G. Fowler, 412 Linwood Ave., Buffalo.  
Secretary-Treasurer: Dr. Sheldon B. Freeman, 196 Linwood Ave., Buffalo.  
Time: Second Thursday of each month.

## CHATTANOOGA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Each member, in alphabetical order.  
Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga, Tenn.  
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

## CHICAGO OPHTHALMOLOGICAL SOCIETY

President: Dr. Georgiana Dvorak-Theobald, 715 Lake St., Oak Park, Ill.  
Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.  
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

## CINCINNATI OPHTHALMIC CLUB

Chairman: Each member, in rotation.  
Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.  
Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

## CLEVELAND OPHTHALMOLOGIC CLUB

Chairman: Dr. Albert J. Ruedemann, Cleveland Clinic, Cleveland.  
Secretary: Dr. B. J. Wolpaw, 2323 Prospect Ave., Cleveland.  
Time: Second Tuesday in October, December, February and April.

COLLEGE OF PHYSICIANS, PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.  
 Clerk: Dr. W. S. Reese, 1901 Walnut St., Philadelphia.  
 Time: Third Thursday of every month from October to April, inclusive.

COLUMBUS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

Chairman: Dr. Harry M. Sage, 9 Buttlers Ave., Columbus, Ohio.  
 Secretary-Treasurer: Dr. Hugh C. Thompson, 289 E. State St., Columbus, Ohio.  
 Place: The Neil House. Time: 6 p. m., first Monday of each month.

CORPUS CHRISTI EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Edgar G. Mathis, 416 Chaparral St., Corpus Christi, Texas.  
 Secretary: Dr. E. King Gill, 416 Chaparral St., Corpus Christi, Texas.  
 Time: Second Thursday of each month from October to May.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Maxwell Thomas, Medical Arts Bldg., Dallas, Texas.  
 Secretary: Dr. J. Dudley Singleton, 1719 Pacific Ave., Dallas, Texas.  
 Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

DES MOINES ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.  
 Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.  
 Time: 7:45 p. m., third Monday of every month from September to May.

DETROIT OPHTHALMOLOGICAL CLUB

Chairman: Members rotate alphabetically.  
 Secretary: Dr. Arthur S. Hale, 1609 Eaton Tower, Detroit.  
 Time: 6:30 p. m., first Wednesday of each month.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. L. A. Hulsebosch, 191 Glen St., Glen Falls.  
 Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.  
 Time: Third Wednesday in October, November, March, April, May and June.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. R. A. Gough, 602 W. 10th St., Fort Worth, Texas.  
 Secretary-Treasurer: Dr. Charles R. Lees, 806 Medical Arts Bldg., Fort Worth, Texas.  
 Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

GRAND RAPIDS EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.  
 Secretary-Treasurer: Dr. Robert G. Laird, 116 E. Fulton St., Grand Rapids, Mich.  
 Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

HOUSTON ACADEMY OF MEDICINE, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. Louis Daily, 1215 Walker Ave., Houston, Texas.  
 Secretary: Dr. Herbert H. Harris, 1004 Medical Arts Bldg., Houston, Texas.  
 Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

## INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. W. Rutherford, 23 E. Ohio St., Indianapolis.

Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.

Place: Indianapolis Athletic Club. Time: 6:30 p. m., second Thursday of each month from November to June.

## KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. E. N. Robertson, Concordia, Kan.

Secretary: Dr. John S. Knight, 1103 Grand Ave., Kansas City, Mo.

Time: Third Thursday of each month from October to June. The November, January and March meetings are devoted to clinical work.

## LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.

Secretary-Treasurer: Dr. Paul Nilsson, 211 Cherry Ave., Long Beach, Calif.

Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

## LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.

Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.

Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:00 p. m., fourth Monday of each month from September to May, inclusive.

## LOUISVILLE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Gaylord C. Hall, Brown Bldg., Louisville, Ky.

Secretary-Treasurer: Dr. Charles K. Beck, Starks Bldg., Louisville, Ky.

Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF  
OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Earle Breeding, 1801 I St. N. W., Washington.

Secretary: Dr. Elmer Shepherd, 1606-20th St. N. W., Washington.

Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

## MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.

Secretary: Dr. Sam H. Sonders, Medical Arts Bldg., Memphis, Tenn.

Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

## MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. Herbert G. Smith, 411 E. Mason St., Milwaukee.

Secretary-Treasurer: Dr. John B. Hitz, 411 E. Mason St., Milwaukee.

Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

## MINNEAPOLIS OPHTHALMOLOGICAL SOCIETY

Chairman: Each member, in alphabetical order.

Secretary: Dr. M. C. Pfunder, 645 Medical Arts Bldg., Minneapolis.

Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

## MONTGOMERY COUNTY MEDICAL SOCIETY

Chairman: Dr. H. V. Dutrow, 1040 Fidelity Medical Bldg., Dayton, Ohio.

Secretary-Treasurer: Dr. Maitland D. Place, 981 Reibold Bldg., Dayton, Ohio.

Place: Van Cleve Hotel. Time: 6:30 p. m., first Tuesday of each month from October to June, inclusive.

MONTREAL OPHTHALMOLOGICAL SOCIETY

President: Dr. L. de G. Joubert, 690 Dunlop St., Montreal, Canada.  
 Secretary: Dr. K. B. Johnston, 1509 Sherbrooke St. W., Montreal, Canada.  
 Time: Second Thursday of October, December, February and April.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Guy Maness, 119-7th Ave., Nashville, Tenn.  
 Secretary-Treasurer: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.  
 Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

NEW HAVEN OPHTHALMOLOGICAL SOCIETY

President: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.  
 Secretary: Dr. Frederick A. Wies, 255 Bradley St., New Haven, Conn.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. E. G. Walls, 619 Maison Blanche Bldg., New Orleans.  
 Secretary-Treasurer: Dr. W. B. Clark, 1012 American Bank Bldg., New Orleans.  
 Place: Louisiana State University Medical Bldg. Time: 8 p. m., second Tuesday of each month from October to June.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. James W. White, 15 Park Ave., New York.  
 Secretary: Dr. Rudolf Aebli, 30 E. 40th St., New York.  
 Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

President: Dr. Arthur M. Yudkin, 257 Church St. New Haven, Conn.  
 Secretary: Dr. Benjamin Esterman, 515 Park Ave., New York.  
 Place: Squibb Hall, 745-5th Ave. Time: 8 p. m., first Monday of each month from October to May, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND  
 OTO-LARYNGOLOGICAL SOCIETY

President: Dr. J. T. Maxwell, 1140 Medical Arts Bldg., Omaha.  
 Secretary-Treasurer: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.  
 Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner;  
 7 p. m., program; third Wednesday of each month from October to May.

PASSAIC-BERGEN OPHTHALMOLOGICAL CLUB

President: Dr. R. N. Berke, 430 Union St., Hackensack, N. J.  
 Secretary-Treasurer: Dr. T. A. Saniacon, 340 Park Ave., Paterson, N. J.  
 Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

PHILADELPHIA COUNTY MEDICAL SOCIETY, EYE SECTION

Chairman: Dr. Walter I. Lillie, 255 S. 17th St., Philadelphia.  
 Secretary: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.  
 Time: First Thursday of each month from October to May.

PITTSBURGH OPHTHALMOLOGICAL SOCIETY

President: Dr. Adolph Krebs, 509 Liberty Ave., Pittsburgh.  
 Secretary: Dr. George H. Shuman, 351-5th Ave., Pittsburgh.  
 Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

RICHMOND OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Rudolph Thomason, Professional Bldg., Richmond, Va.  
 Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.  
 Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

## ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Edwin S. Ingersoll, 26 S. Goodman St., Rochester, N. Y.  
 Secretary-Treasurer: Dr. Charles T. Sullivan, 277 Alexander St., Rochester, N. Y.  
 Place: Rochester Academy of Medicine, 1441 East Ave. Time: 8 p. m., second Wednesday of each month from September to May.

## ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. B. Y. Alvis, Carleton Bldg., St. Louis.  
 Secretary: Dr. Carl C. Beisbarth, 3720 Washington Blvd., St. Louis.  
 Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

## SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Oscar H. Judkins, 414 Navarro St., San Antonio, Texas.  
 Secretary-Treasurer: Dr. Wilfred E. Muldoon, 414 Navarro St., San Antonio, Texas.  
 Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE,  
EAR, NOSE AND THROAT

Chairman: Dr. Russell Fletcher, 490 Post St., San Francisco.  
 Secretary: Dr. Avery Morley Hicks, 490 Post St., San Francisco.  
 Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except May, June, July and December.

## SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. I. Henry Smith, Slaterry Bldg., Shreveport, La.  
 Secretary-Treasurer: Dr. David C. Swearingen, Slaterry Bldg., Shreveport, La.  
 Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

## SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Walter W. Henderson, 407 Riverside Ave., Spokane, Wash.  
 Secretary: Dr. Robert L. Pohl, 407 Riverside Ave., Spokane, Wash.  
 Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

## SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. James F. Cahill, 428 S. Salina St., Syracuse, N. Y.  
 Secretary-Treasurer: Dr. I. Herbert Katz, 713 E. Genesee St., Syracuse, N. Y.  
 Place: University Club. Time: First Tuesday of each month except June, July and August.

## TORONTO ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. W. R. F. Luke, 316 Medical Arts Bldg., Toronto, Canada.  
 Secretary: Dr. W. T. Gratton, 216 Medical Arts Bldg., Toronto, Canada.  
 Place: Academy of Medicine, 13 Queens Park. Time: First Monday of each month, November to April.

## WASHINGTON, D. C., OPHTHALMOLOGICAL SOCIETY

President: Dr. Ernest Sheppard, 927 Farragut Sq. N. W., Washington, D. C.  
 Secretary-Treasurer: Dr. E. Leonard Goodman, 1801 I St. N. W., Washington, D. C.  
 Place: Episcopal Eye and Ear Hospital. Time: 7:30 p. m., first Monday in November, January, March and April.

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